



**First South East European  
Regional CIGRÉ Conference**

**SEERC**

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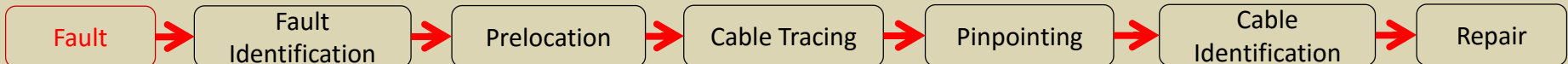
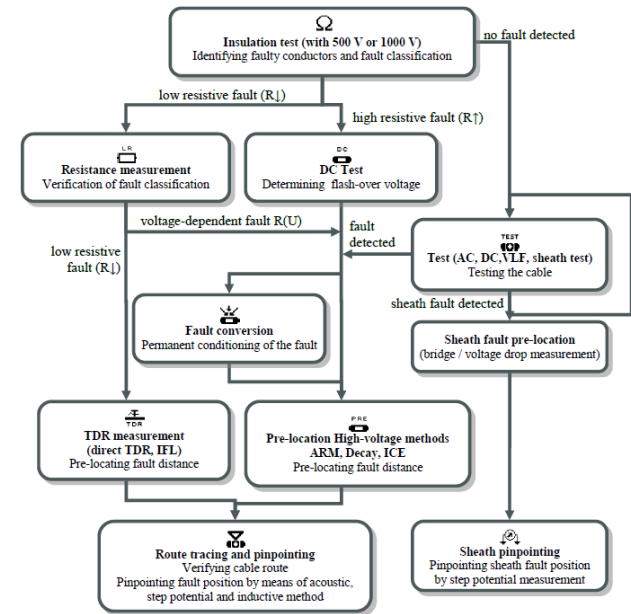
# **Cable Fault Location on long HVAC and HVDC Cable Systems**

2-13

Dr. Frank Petzold  
Dominik Nowak  
Matthias Müller

# Challenges in cable fault location on HVAC and HVDC cable systems

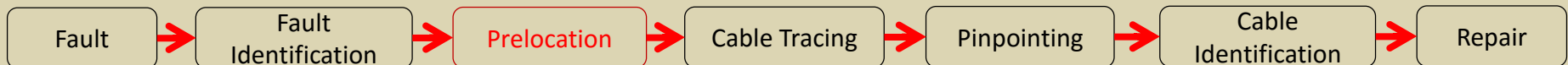
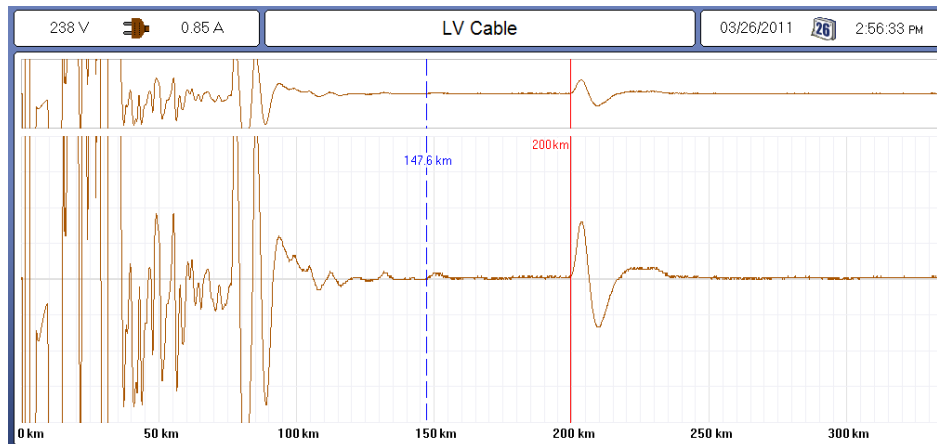
- Cable fault location (CFL) is a process
- Different types of possible cable faults (CF) asks for various number of test methods
- Today's base of experience is still limited
- Characteristics of CF can change with time and during the test
- Big influence of laying conditions and HVAC system design
- ▶ All CFL methods have limitations and needs to be adopted to specific environment of HVAC and HVDC cable systems



# Prelocation of cable faults

## • Time Domain Reflectometry (TDR)

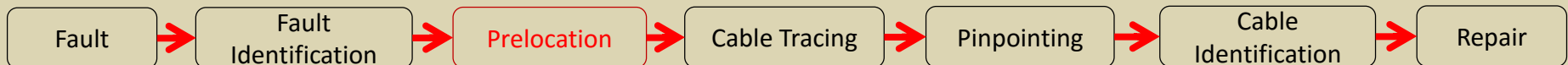
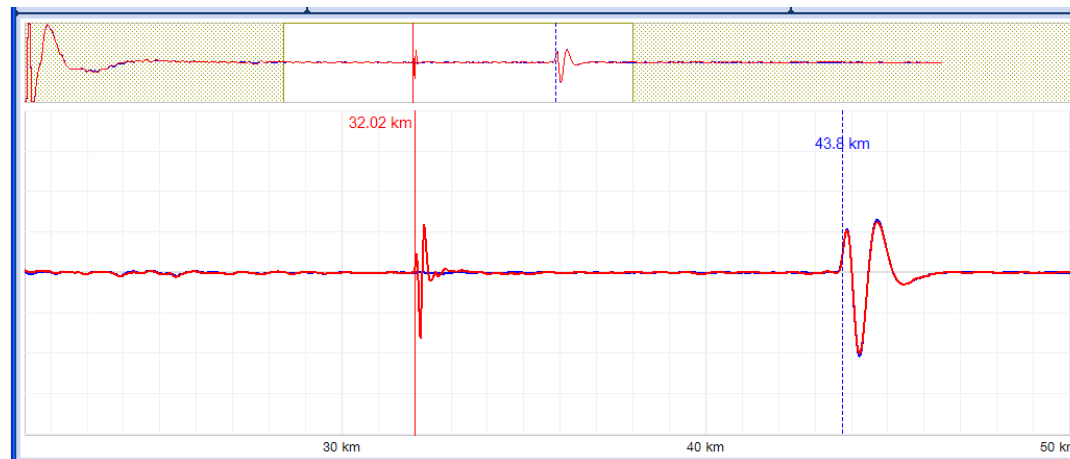
- CFL up to 500km cable length possible with good TDR equipment
- Well proven on low-resistance faults
- Correction methods for damping and dispersion important for long cables
- Documented reference fingerprint traces are very helpful



# Prelocation of cable faults

- **Arc Reflection Method (ARM)**

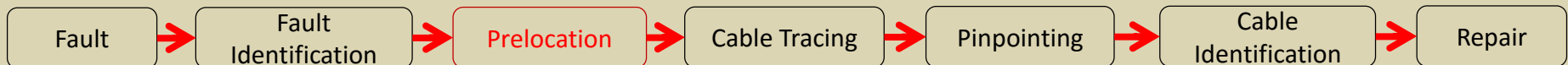
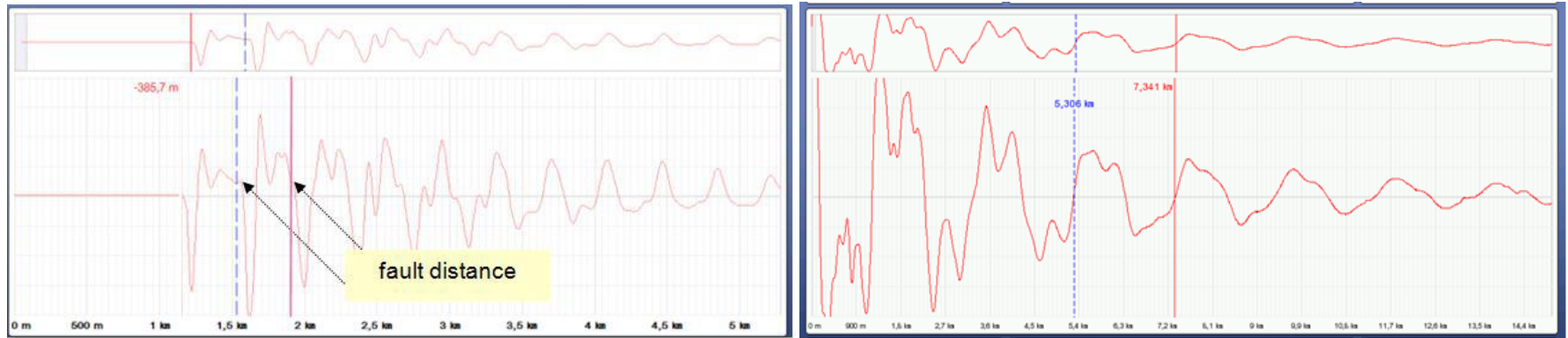
- Limited to ca. 40 km cable length
- Method is well proven on high-resistance faults (makes them low-ohmic)
- Inductive HV filter design provide a good ARC stabilization and multiple TDR traces are used for selection of the best trigger point.



# Prelocation of cable faults

- **ICE and DECAY**

- Well proven on high resistance faults with certain DC withstand voltage
- Strongly dependent on cable fault condition
- Surge Generator up to 80 kV with high energy used
- Limited for fault distances up to 30 km due to physics

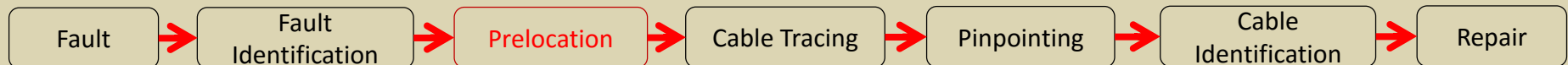


# Prelocation of cable faults

- **Burning methods**



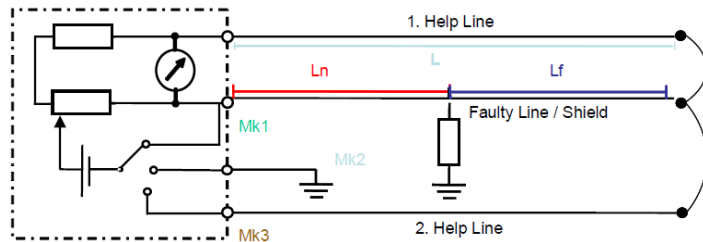
- Fault conditioning with high voltage and high current to achieve low ohmic status
- 40kV/25kVA burning transformer well proven in combination with TDR on difficult faults
- Provides a TDR capability up to 500 km cable length



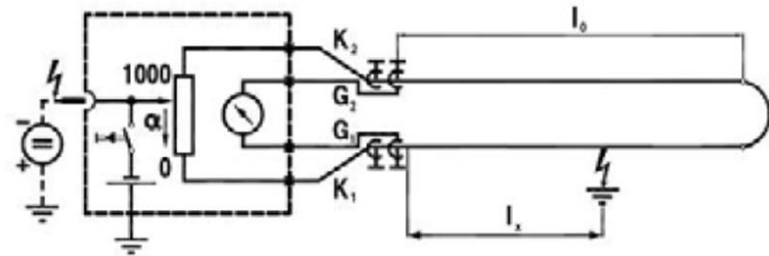
# Prelocation of cable faults

## • Bridge Method

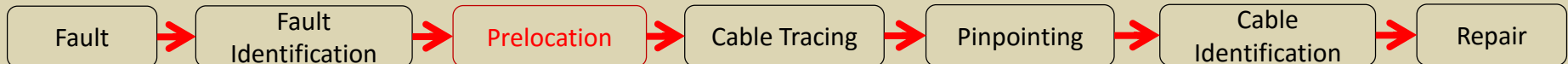
- Highly dependent on cable design -> AC cables with Graaf Method  
-> DC cables with Murray Method (correction of different cable parameter needed)
- Reliable cable data crucial for precise prelocation
- Long distance fault location possible
- Voltage drop method provide easier application of Murray Method



Graaf Method



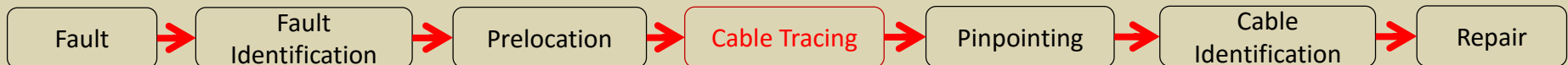
Murray Method



# Cable tracing on HVAC and HVDC cables

- **Audio frequency**

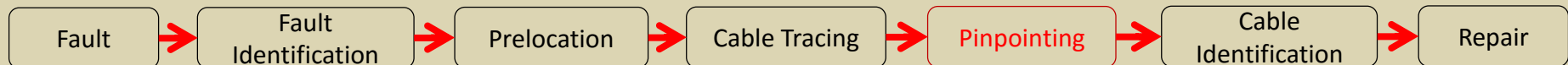
- 200W Transmitter with D-Class Amplifier and various frequencies
- Special inductive coupling system for low frequencies
- Normal Receiver used on Land Cables and Shallow Water
- Special Audio Frequency Receiver installed on ROV for deep water application



# Pinpointing of cable faults on HVAC and HVDC cables

- **Acoustic location**

- Noise cancelation technology important
- Combined analysis of acoustic and magnetic impulse most promising method
- Installation inside ducts and pipes makes pinpointing challenging on land cables



# Safety Issues

- **Safe discharge in case of charged cables**
  - In case of fault confirmation with DC voltage and no breakdown
  - In case of surging and no discharge at the fault place
  - Discharge energy :  $P = U^2 \times C / 2$

Example : 100 km cable length with app. 25  $\mu$ F capacitance  
DC voltage for fault confirmation 130 kV  
-> in case of no breakdown/flash over - > the Energy of **422 kJ** must be discharged safely

