

CIGRE **e**-Session 2020

A3-204

In-service Diagnosis of Grading Capacitor Dielectric Deterioration

Phil Moore

Presenter: Phil Moore phil.moore@elimpus.com

14 July 2020



1



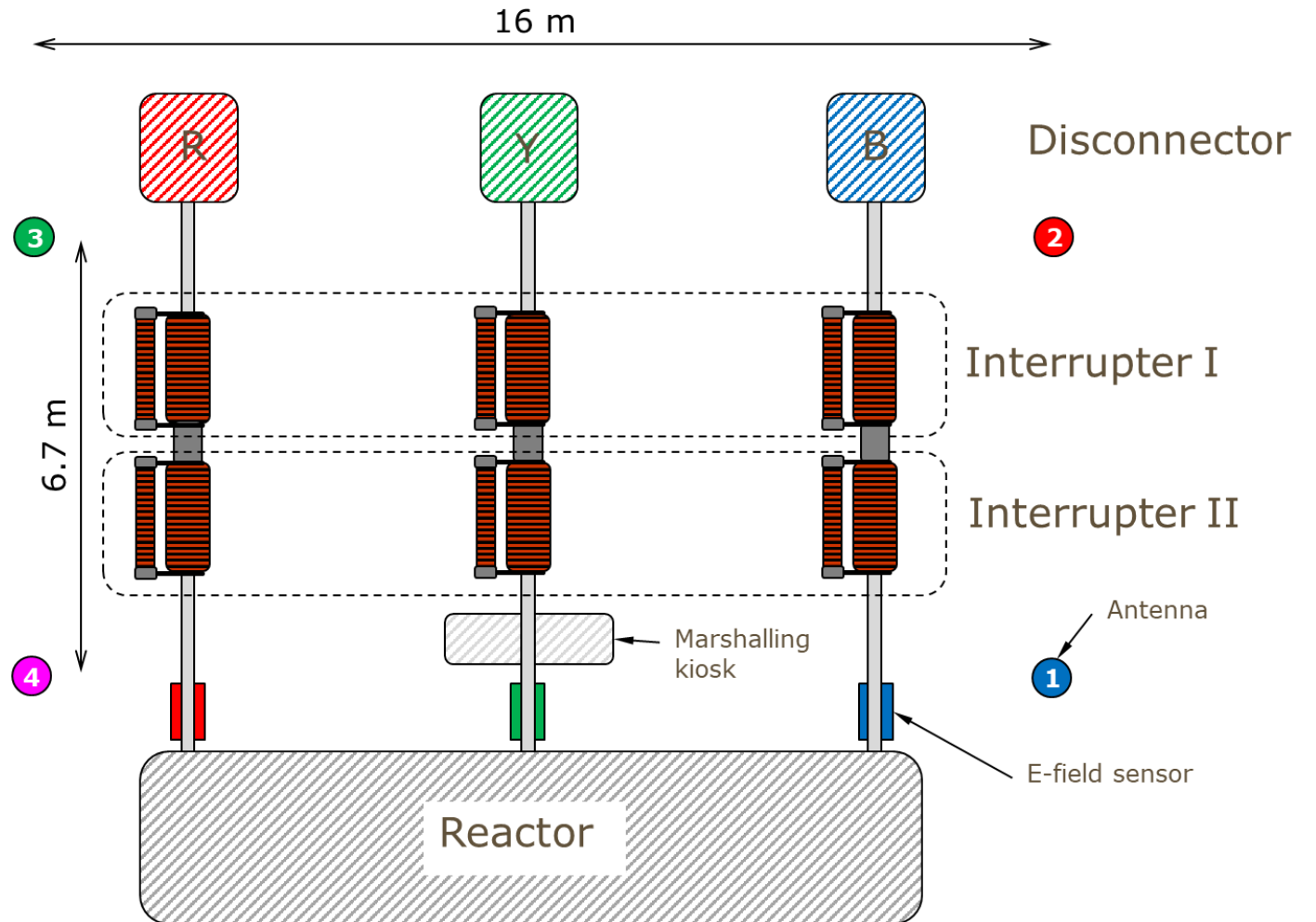
CONTENTS

- Introduction
- Methodology
- Results
- Conclusion

Methodology

Field measurements

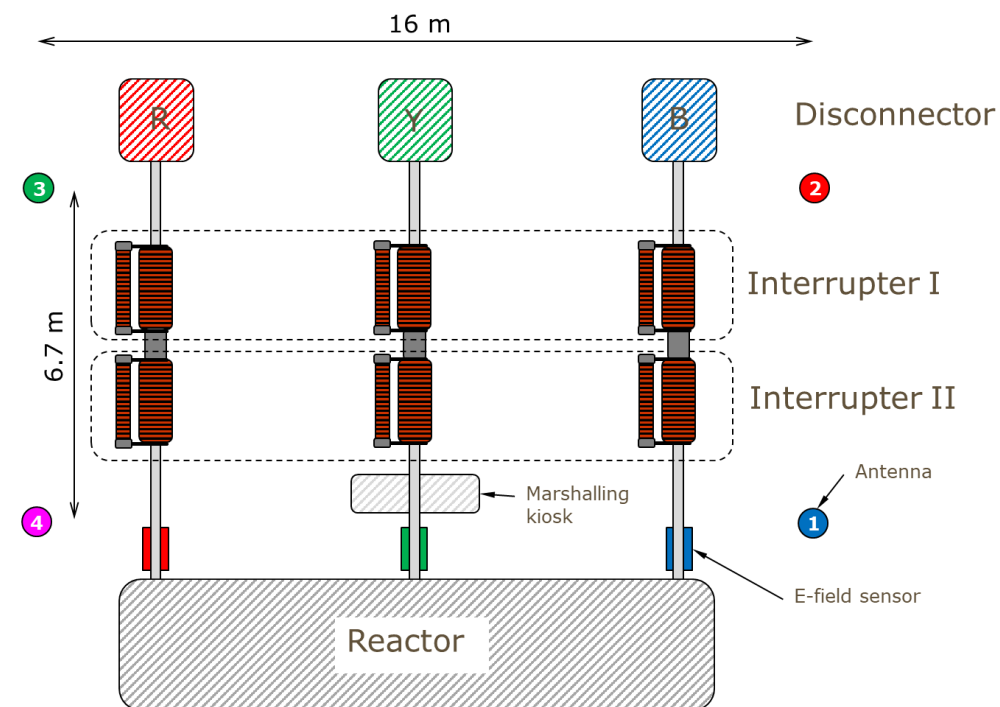
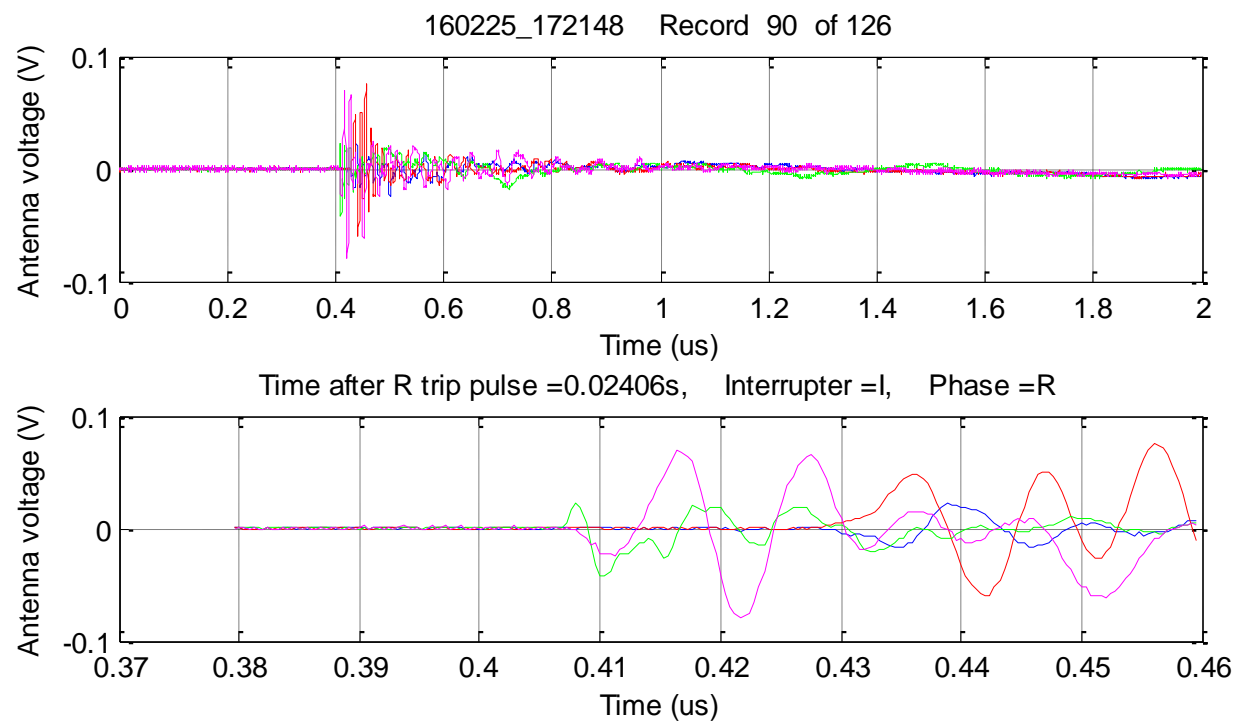
- RF PD signals
 - ✓ 4x wideband antennas
 - ✓ 2.5 GSps
- 50Hz electric field
 - ✓ 3x electric field sensors
 - ✓ 20 kSps
- Trip current pulses
 - ✓ 3x electronic current clamp
 - ✓ 20 kSps





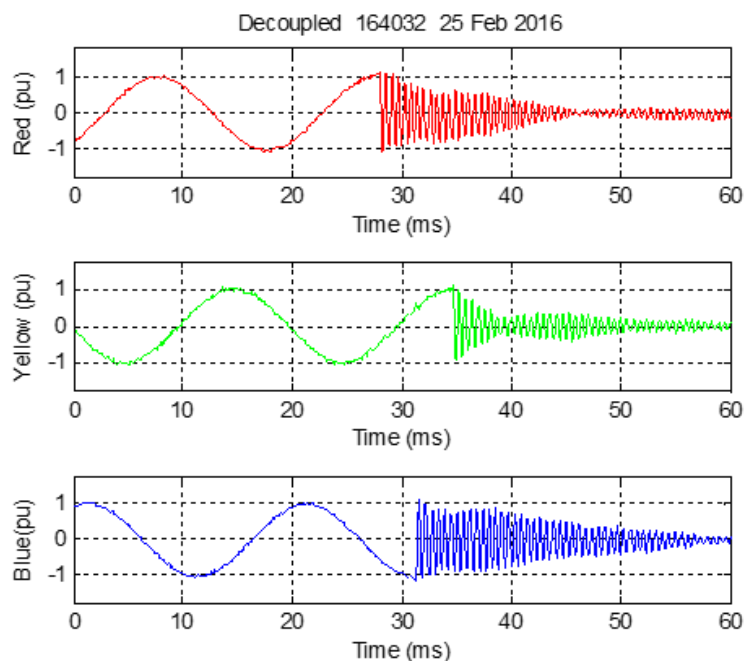
Methodology

PD Location

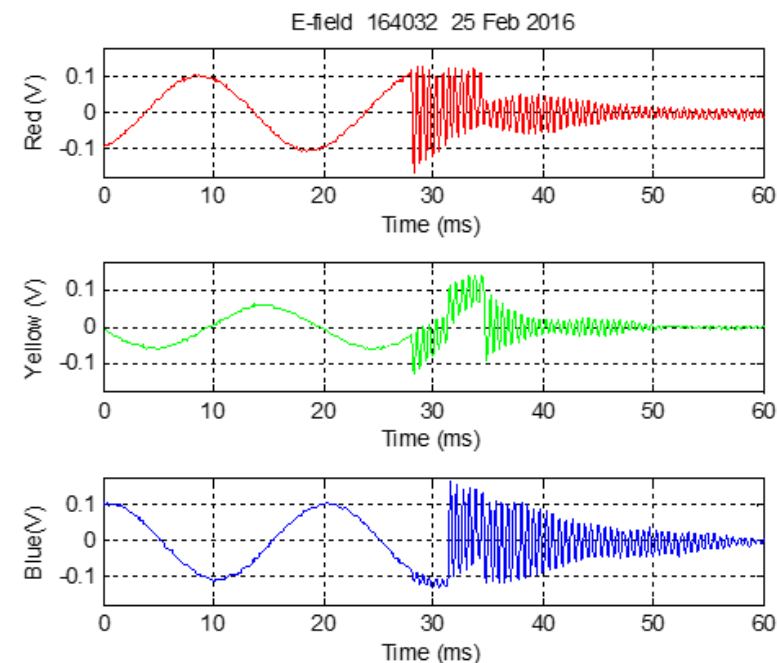


Methodology

Reactor terminal voltage calculation



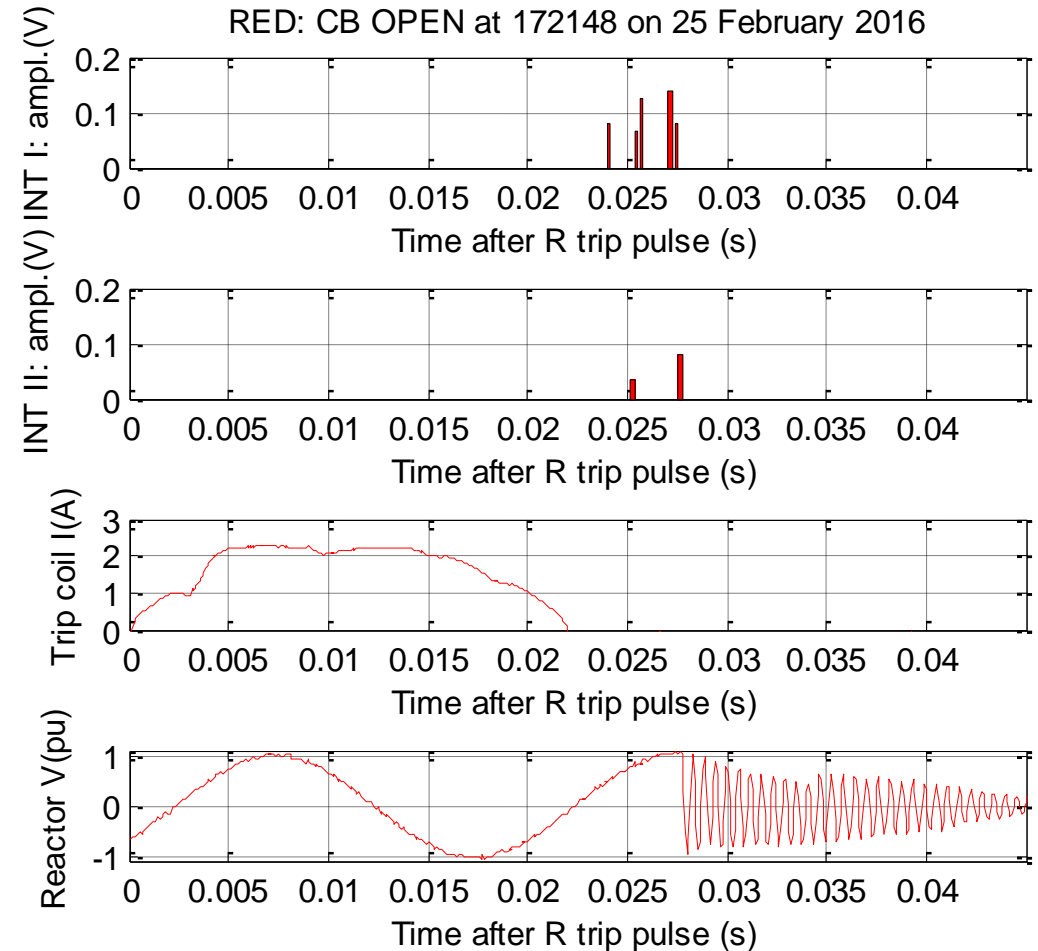
$$\begin{bmatrix} v_r \\ v_y \\ v_b \end{bmatrix} = \begin{bmatrix} 9.55 & -4.86 & 1.01 \\ -4.84 & 13.14 & -4.65 \\ 0.90 & -4.38 & 9.47 \end{bmatrix} \begin{bmatrix} s_r \\ s_y \\ s_b \end{bmatrix}$$



Results

After grading capacitor replacement

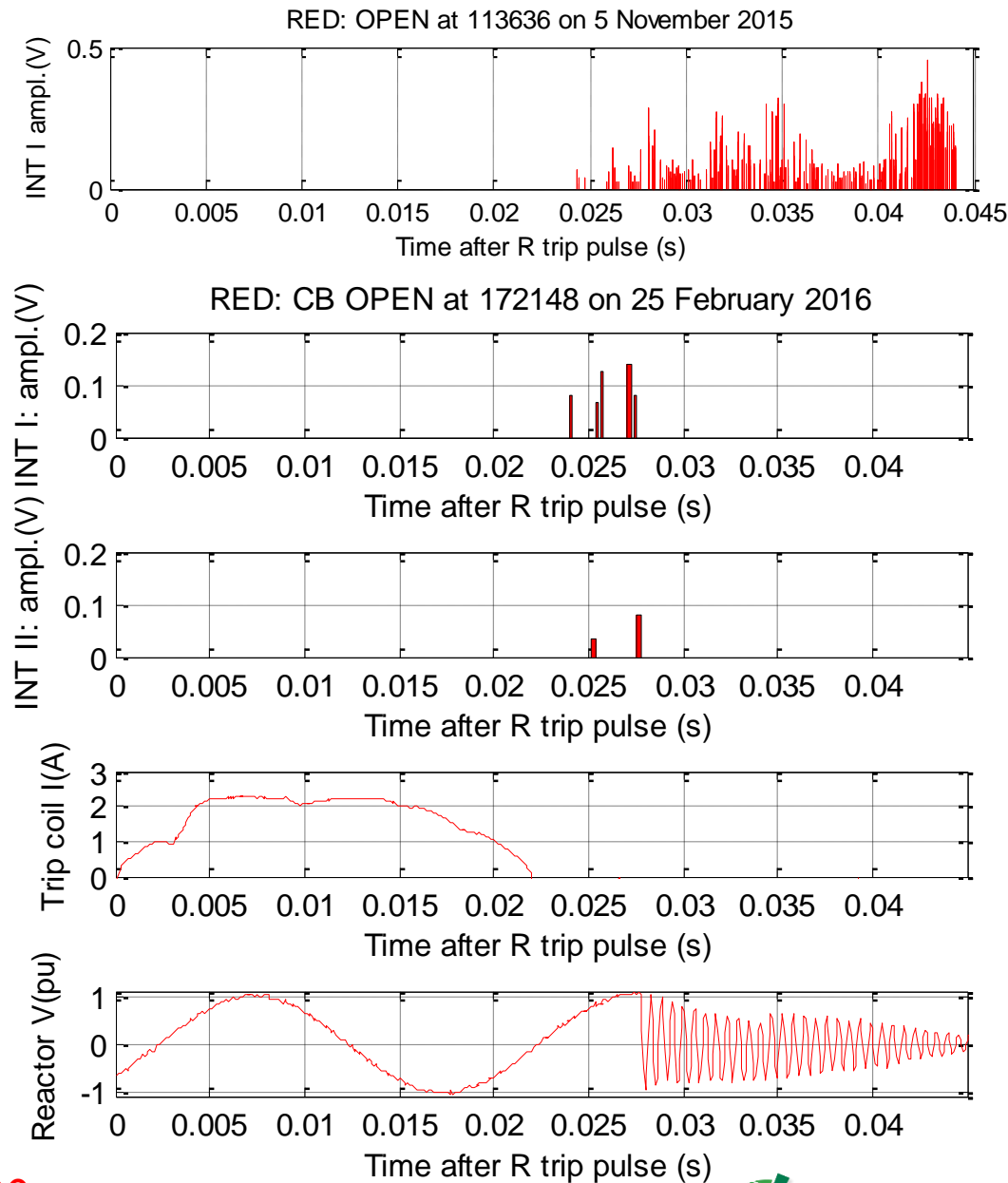
- PD emissions from interrupter I
- PD emissions from interrupter II
- Trip coil current
- Reactor terminal voltage



Results

Before grading capacitor replacement

- PD emissions from interrupter I before grading capacitor was replaced
- Plot from previous slide (i.e. with new grading capacitor)



Results

Grading capacitor investigation

- Grading capacitors were tested in HV laboratory:

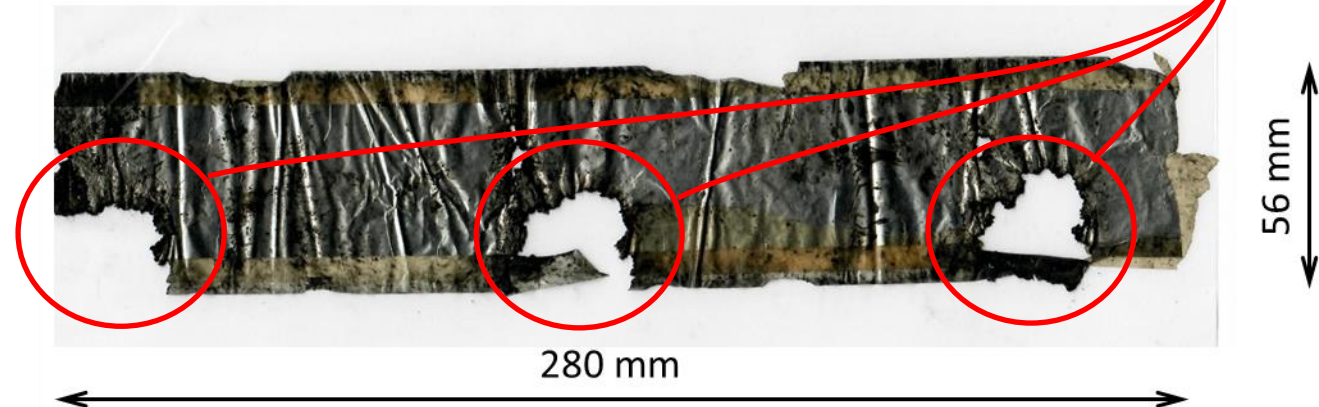
Phase	Interrupter	% dissipation factor	PD inception voltage
Red	I	0.31	9 kV
Red	II	0.025	51 kV
Yellow	I	0.025	51 kV
Yellow	II	0.032	37 kV

- Red I was dismantled



Example grading capacitor (not unit removed from CB)

PD damage to capacitor foils



Conclusion

- Methodology allows evaluation of CB trip time, arcing time and phase opening sequence in addition to grading capacitor health.
- Measurements are in-service and non-invasive.
- Proven method: results taken from site trial were used as basis for grading capacitor replacement.
- Feasible to test a circuit breaker within 0.5 day.
- Can be adapted for scheduled CB operations.
- Can be adapted for GIS applications.