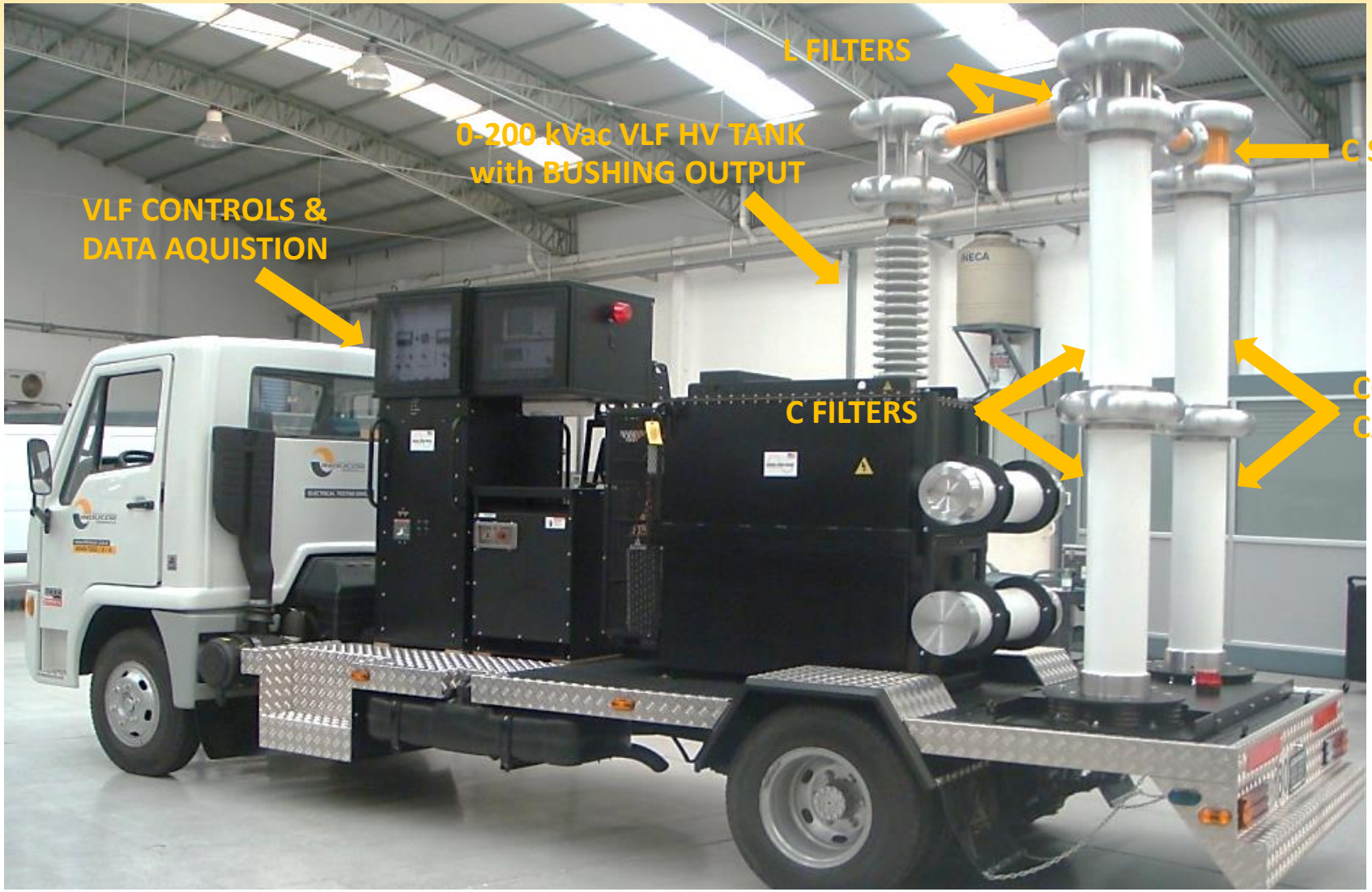
MONITORED VLF WITHSTAND TESTS
w/TAN DELTA & PARTIAL DISCHARGE
using 0 – 200 kVac VLF

THE WORLDS SOURCE FOR HIGH VOLTAGE TEST EQUIPMENT

VLF CABLE TESTING SYSTEM @ 0-200 kVac

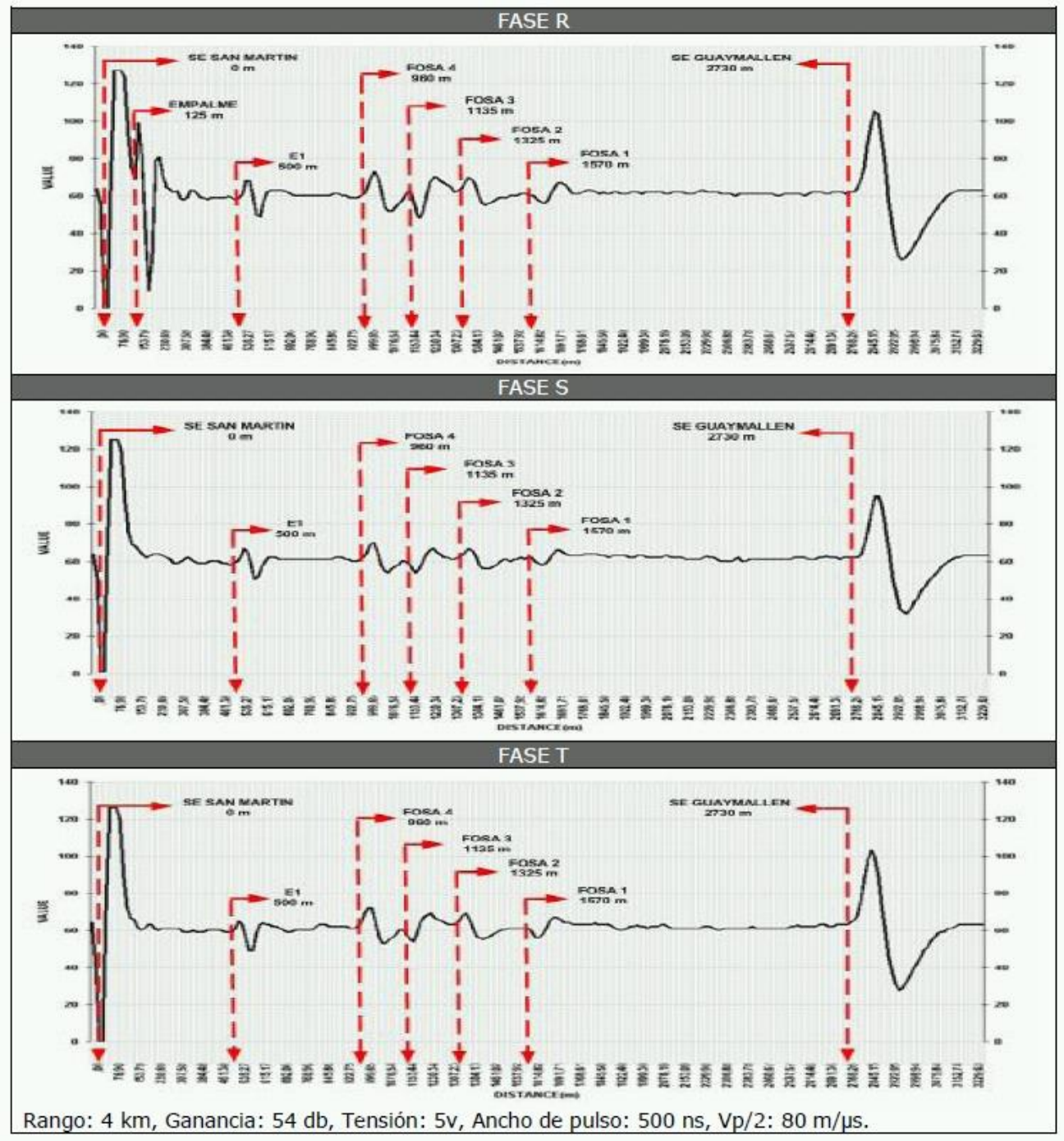
WITHSTAND PARTIAL DISCHARGE TAN DELTA



VARIOUS TEST TO BE PERFORMED

- Differential Conductor Reflectometry
- VLF Tan Delta
- VLF Withstand
- VLF Partial Discharge
- Measurements on ground system
- X-ray Analysis at conflictive points
- Infrared Thermography
- PD Acoustic Method external terminal
- PD Ultrasonic with Magnetic Sensors

TDR TRACE TO CAPTURE SIGNATURE



Rango: 4 km, Ganancia: 54 db, Tensión: 5v, Ancho de pulso: 500 ns, Vp/2: 80 m/µs.

VLF TESTS WITH 200 kVac PEAK

Tan Delta & Partial Discharge Test

U_{RMS} (kV)	$U_{O\ RMS}$ (kV)	$U_{O\ PEAK}$ (kV)	½·$U_{O\ PEAK}$ (kV)	1·$U_{O\ PEAK}$ (kV)	1.5·$U_{O\ PEAK}$ (kV)	Max. k factor tested with 200 kV peak
69	40	56.5	28.2	56.5	84.7	3.5
110	64	90.5	45.2	90.5	135.7	2.2
132	76	107.5	53.7	107.5	161.22	1.8
150	87	123	61.5	123	184.5	1.6
220	127	179.6	89.8	179.6	269.4	1.1
275	160	226.3	113.1	226.3	339.4	0.8
330	190	268.7	134.3	268.7	403.0	0.7
380	220	311.1	155.5	311.1	466.6	0.6
500	290	410.1	205.0	410.1	615.1	0.4

Multiples of U_0 peak if tested at 200 kVac peak.

CASE STUDY OF 132 kV XLPE CABLE

Withstand Test

$U_{O\ RMS}$ (kV)	$U_{O\ PEAK}$ (kV)	½·$U_{O\ PEAK}$ (kV)	1·$U_{O\ PEAK}$ (kV)	1.5·$U_{O\ PEAK}$ (kV)	Max. k factor tested with 200 kV peak
76	107	53	107	161	1.86

Conductor Cross-Section		Capacitance	Max. Distance in (km) Tested with VLF-200CMF		
mm²	*Kcmil*	*µF/km*	*@0.1 Hz*	*@0.05 Hz*	*@0.01 Hz*
630	1250	0.18	4.1	8.3	20.8
1000	2000	0.27	2.7	5.5	13.8
2000	4000	0.39	1.9	3.8	9.6

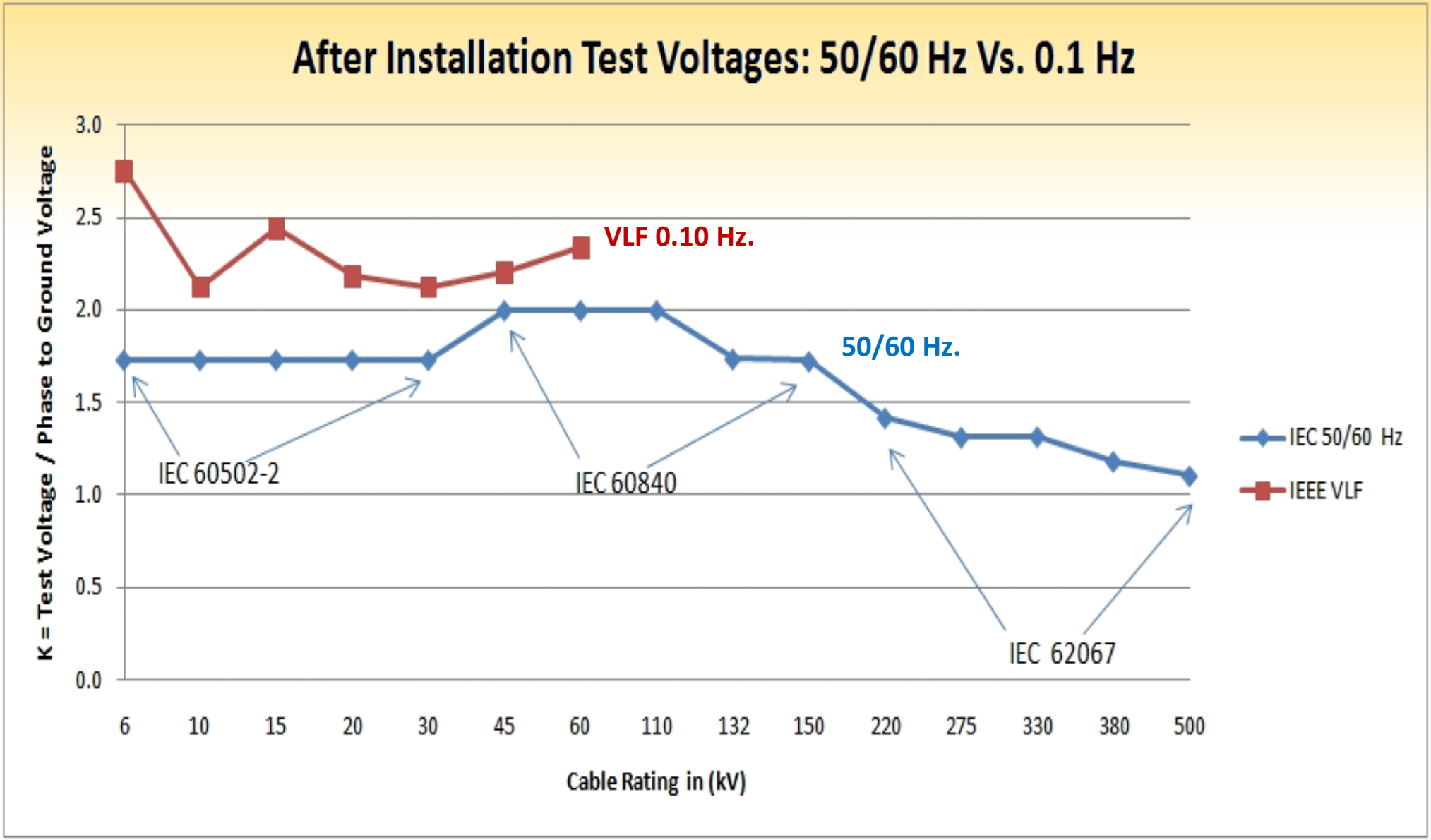
CASE STUDY OF 220 kV XLPE CABLE

Withstand Test ?

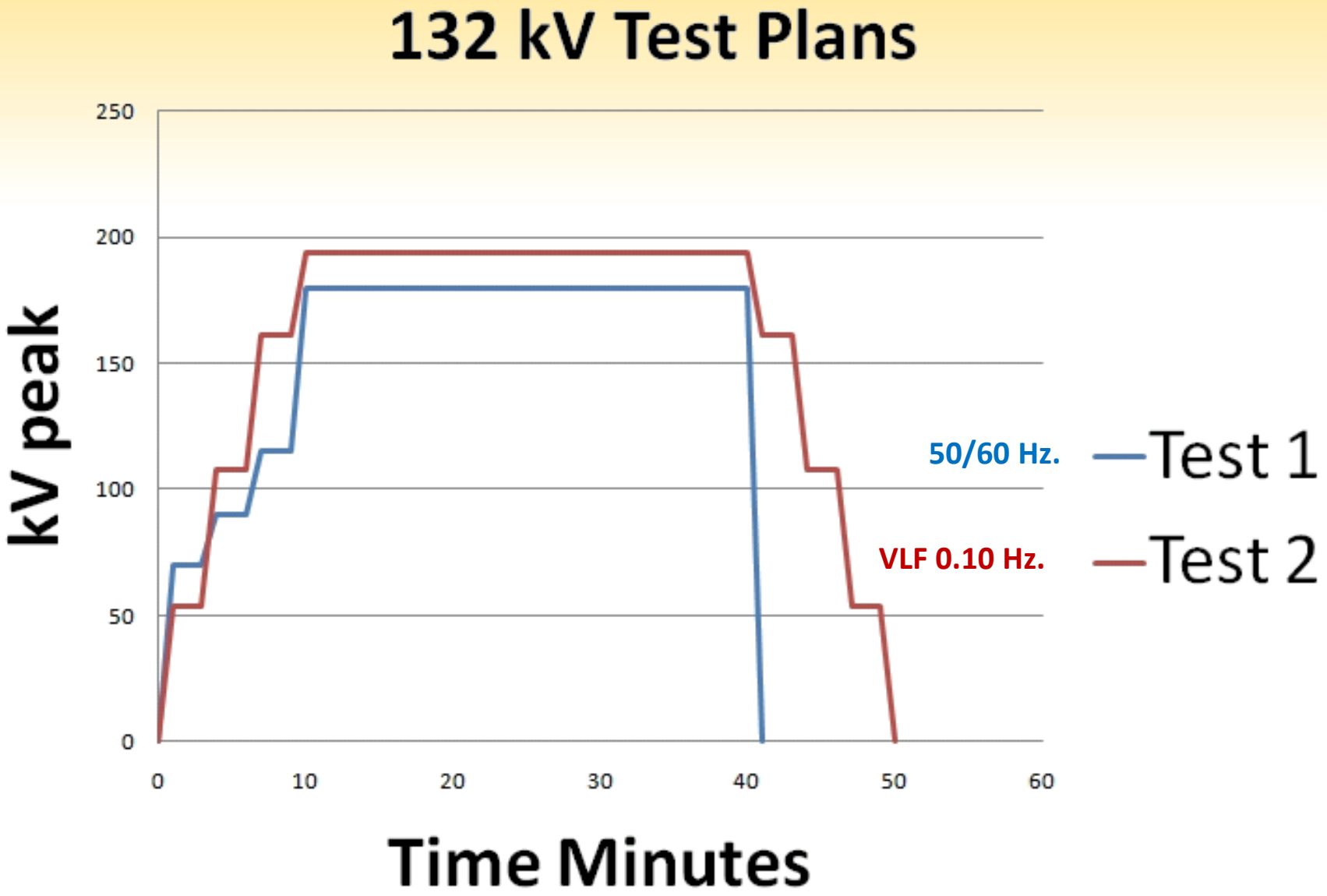
$U_{O\ RMS}$ (kV)	$U_{O\ PEAK}$ (kV)	½·$U_{O\ PEAK}$ (kV)	1·$U_{O\ PEAK}$ (kV)	1.5·$U_{O\ PEAK}$ (kV)	Max. k factor tested with 200 kV peak
127	179.6	89.8	179.6	269.4	1.1

Conductor Cross-Section		Capacitance	Max. Distance in (km) Tested with VLF-200CMF		
mm²	*Kcmil*	*µF/km*	*@0.1 Hz*	*@0.05 Hz*	*@0.01 Hz*
630	1250	0.15	5	10	25
1000	2000	0.19	3.9	7.8	19.7
2000	4000	0.27	2.7	5.5	13.8

IEC vs. IEEE TEST VOLTAGES



IEC vs. IEEE TEST VOLTAGES @ RMS



TESTS PERFORMED IN COLUMBIA SA

TAN DELTA - TYPICAL SCREEN

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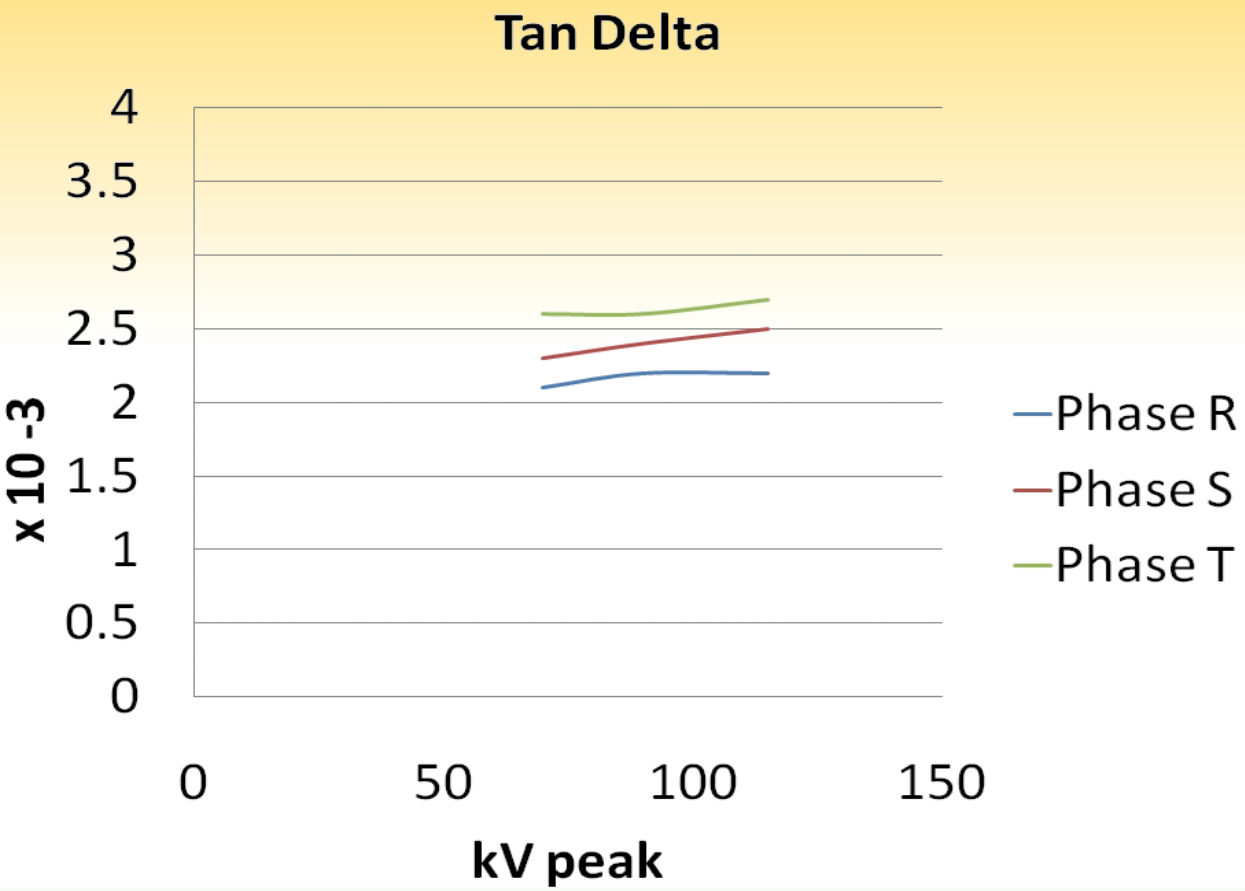


		Tan Delta x 10 -3		
kVpeak	Hz	Phase R	Phase S	Phase T
70	0.05	2.1	2.3	2.6
90	0.05	2.2	2.4	2.6
115	0.05	2.2	2.5	2.7

TD TEST RESULTS INTERPRETATION

FOUR PRIMARY INDICATORS

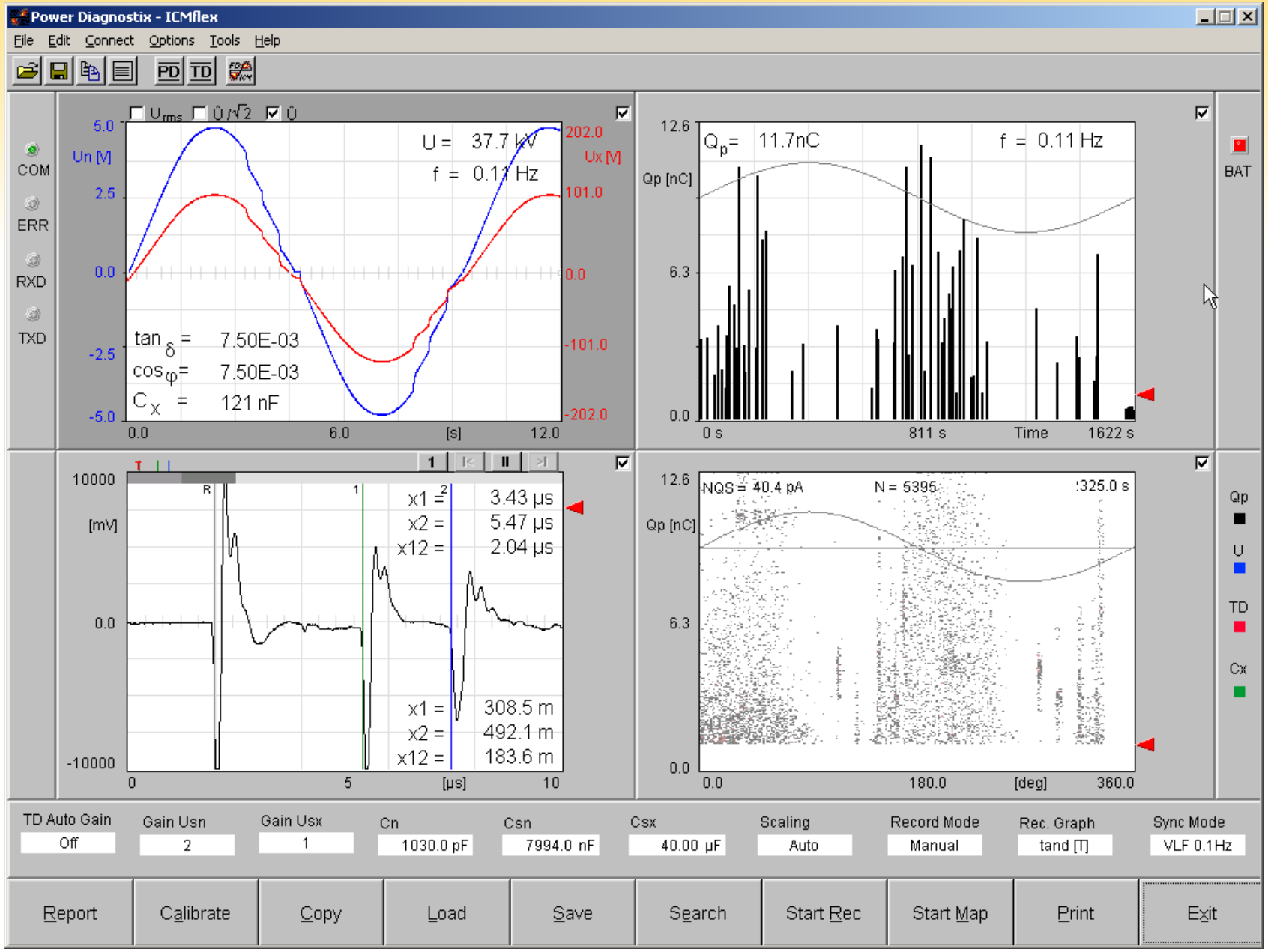
- **TD Stability**: TD drift over time
- **TD vs. Voltage**: TD vs. increasing voltage (Tip-Up)
- **Absolute Value**: Compare to factory new
- **History:** Trending & comparison over time.

TD DIVIDER CONNECTION TO BUSHING

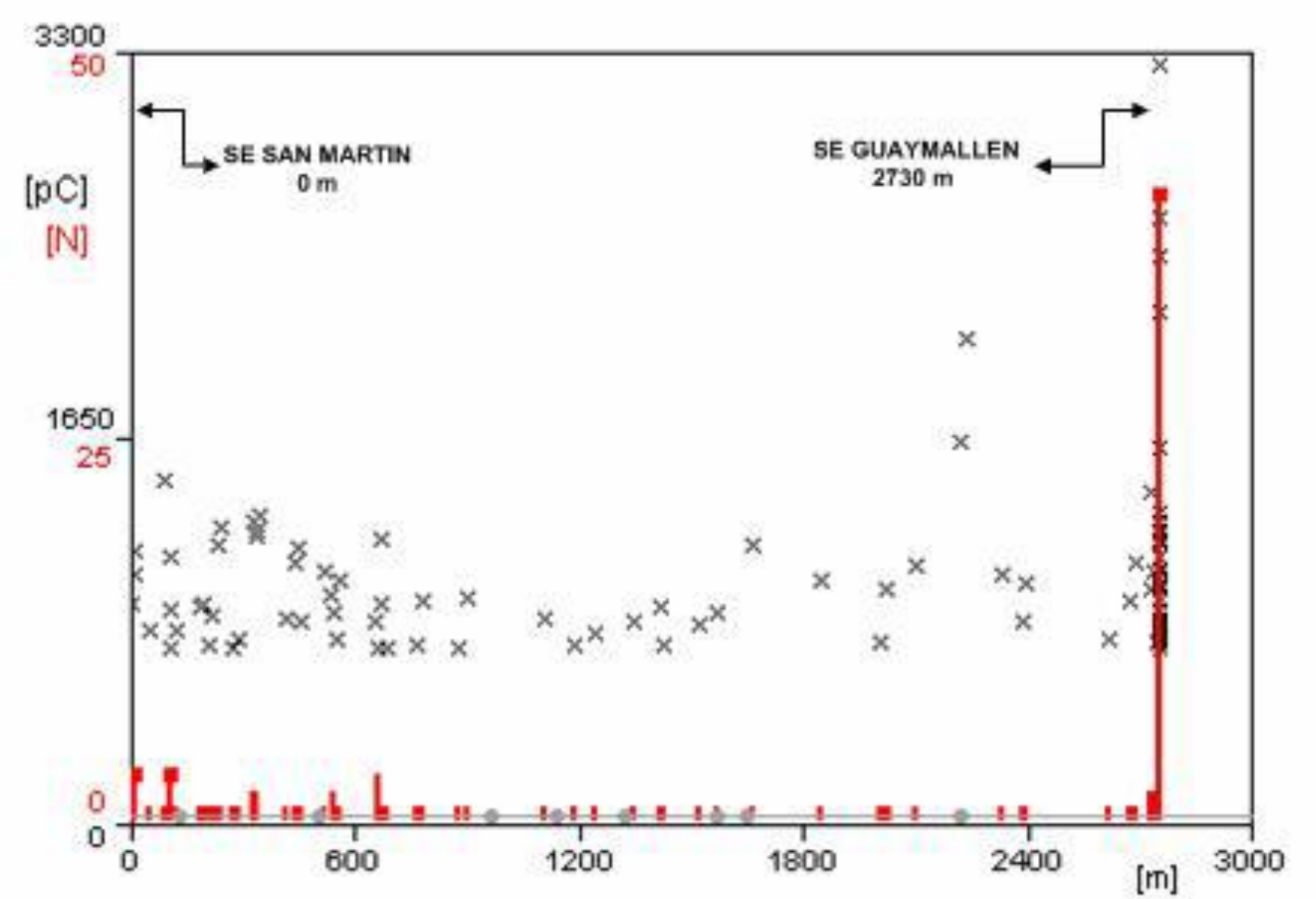
PD TEST SETUP AND CALIBRATION

- Cable Map? Do you know where everything is?
- TDR/Radar Signature for Cable Analysis
  - Length
  - Splices - how many and where
  - Propagation velocity – only one cable type?
- PD Measurement Calibration
  - Inject 0.5, 1, or 2 nC signal
  - Verify Calibration Signals Received via TDR

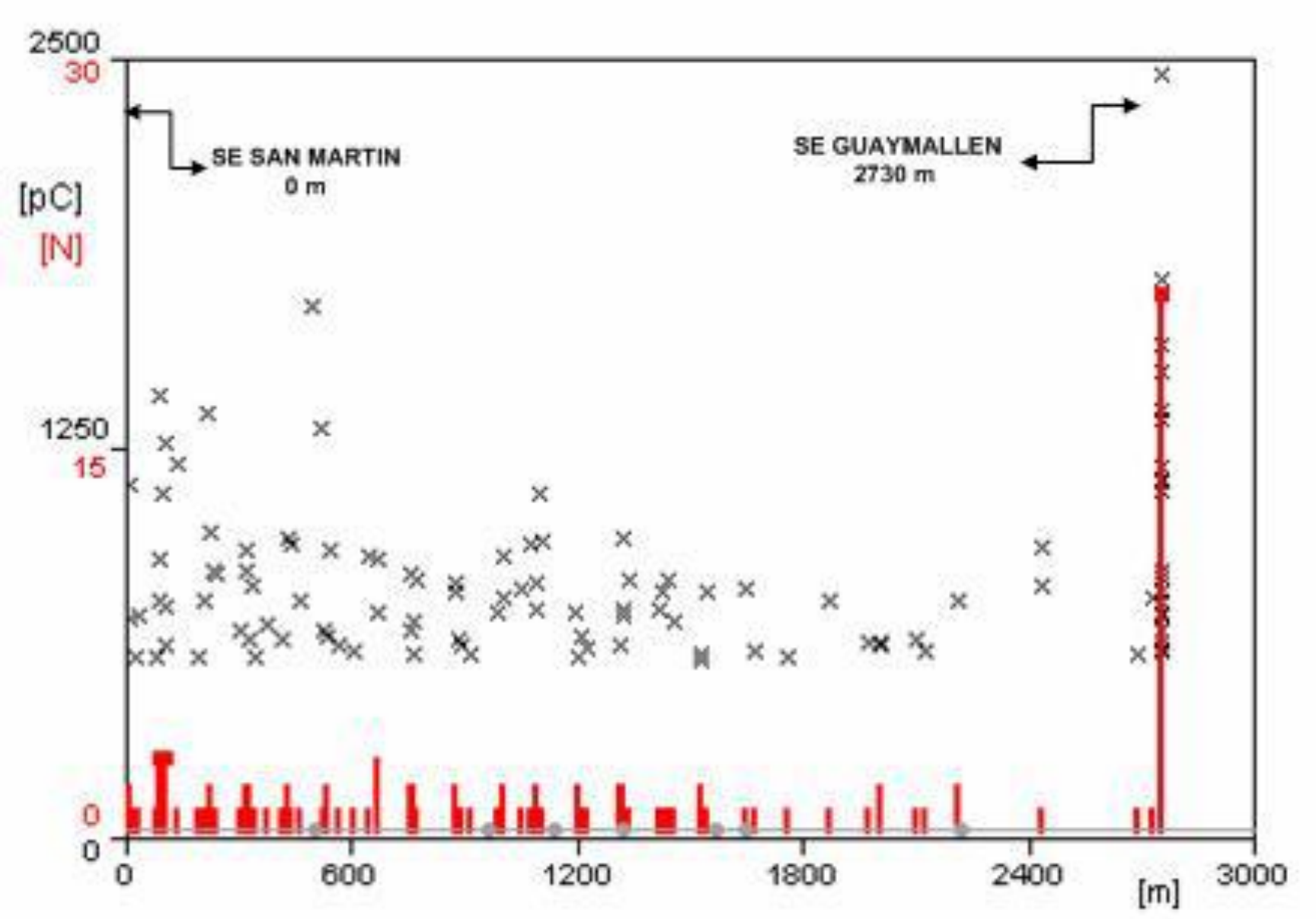
PARTIAL DISCHARGE- TYPICAL SCREEN



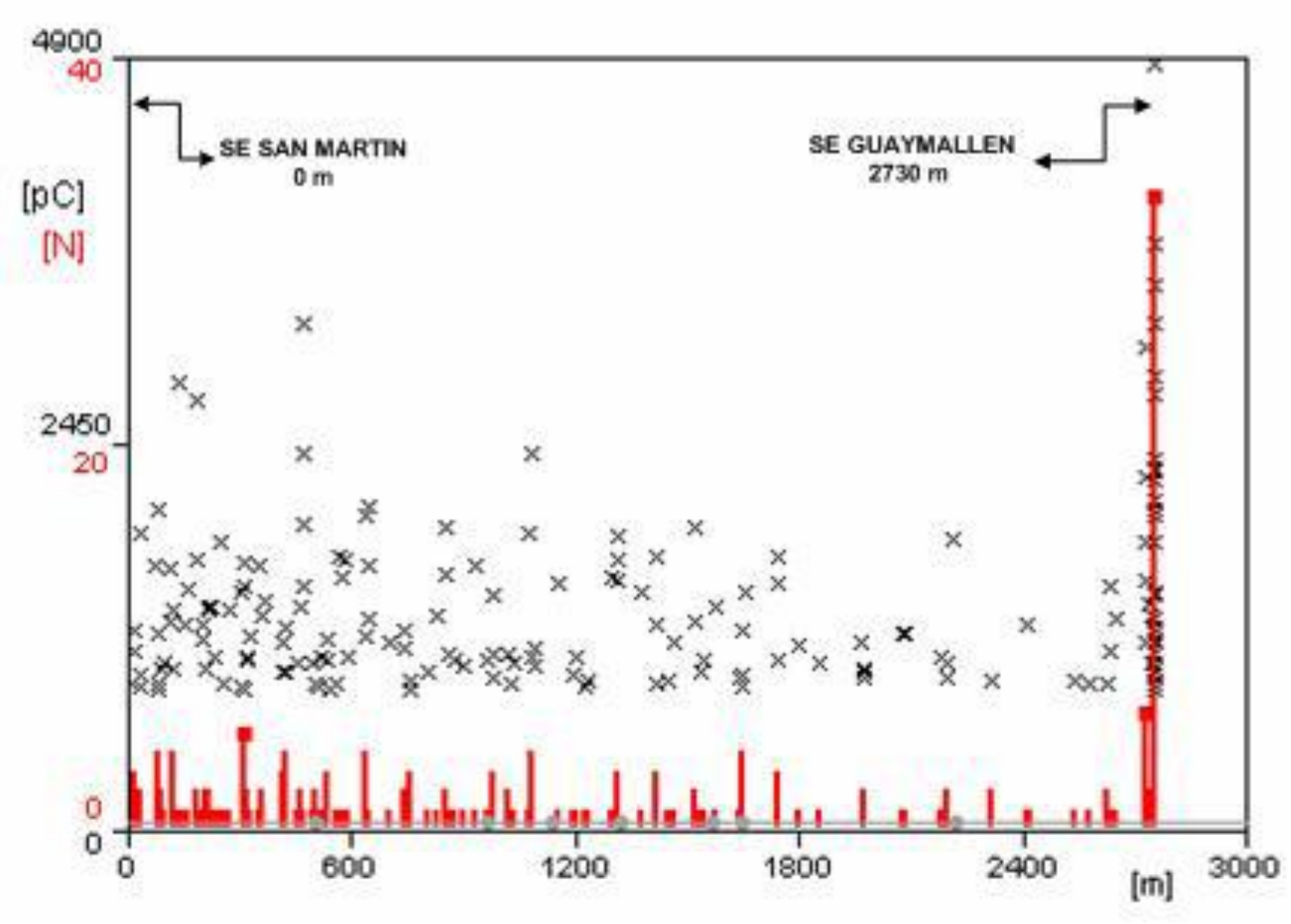
Phase R PD Map



Phase S PD Map



Phase T PD Map



PD INTERPRETATIONS

- Voltage PD Inception & Extinction Voltages
- PD Levels at Critical Voltages
- Frequency
- Location
- Discharge Pattern (phase resolved)
- Phase to Phase Comparisons
- Year to Year Comparisons

SAME METERS & METHODS USED
JUST A DIFFERENT VOLTAGE SOURCE

- Very Low Frequency @ 0.10 Hz. & 0.05 Hz.
- Voltage Source Used for Field Testing Cable
  - Tan δ/Power Factor Measurements
  - Partial Discharge Detection and Measurement