

# Study on Pulse Response Aiming to Water Tree Diagnosis for Power Cables with Spatial Resolution

## Background

- Underground **cable is long**, but degradation is localized.
- **Partial replacement** may be more cost-effective than full replacement.

The cable is aged. Let's repair full length.

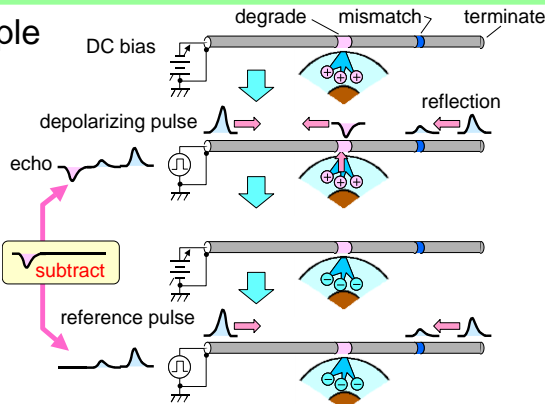
I know only this part is degraded.



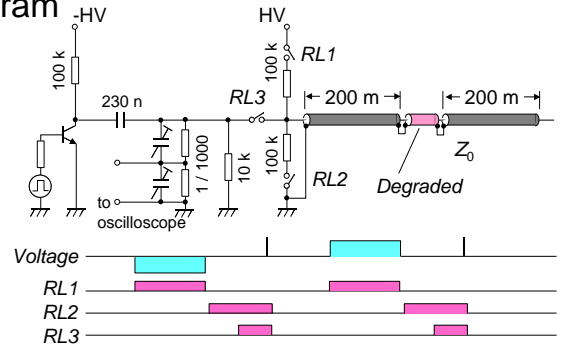
## Objective

- **Locate** degradation due to water trees.

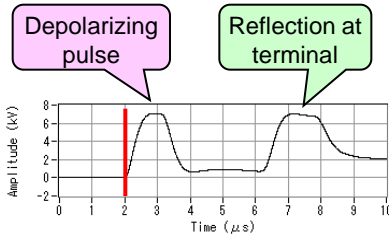
## Principle



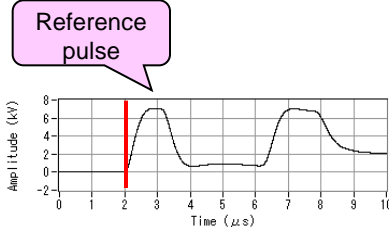
## Diagram



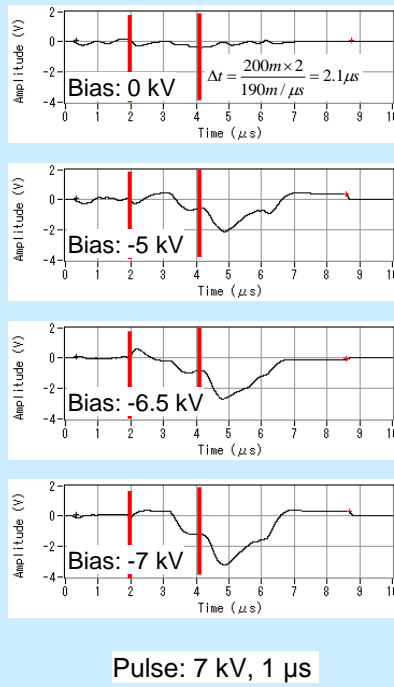
## Result



These two echo signals look quite similar, but subtraction emphasizes a small signal from the degraded region.



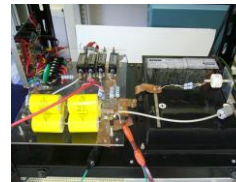
## Subtracted signals



Water trees



Terminals



Hand made pulsar



Measurement system

## Conclusions

- Partial degradation by **water tree** was located as an echo in time-domain measurement.
- Water tree was recognized as an **electret**, of which behavior was influenced by pre-biasing.
- Degradation signal was discriminated from various other echoes from mismatching points.
- The technique is **quite feasible** and attractive.
- Spatial resolution would be as short as 100 m.

Released charge from the degraded region at  $x_0$ :

$$\int_0^{\infty} i(x_0, t) dt = \frac{\int_0^{\infty} v(0, t + \frac{x_0}{c}) dt}{Z_0}$$

$c$ : propagation speed

$Z_0$ : characteristic impedance

Bias (kV)	Pulse (kV)	Charge intensity (nC)
0	7	--
-5	7	-79
-6.5	7	-120
-7	7	-141