

# **Diagnostic Testing Techniques for Distribution and Transmission Cables** *(other than Historical PD Tests)*

## **Experience with available techniques**

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**NEETRAC**

**ICC Education**

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# Learnings

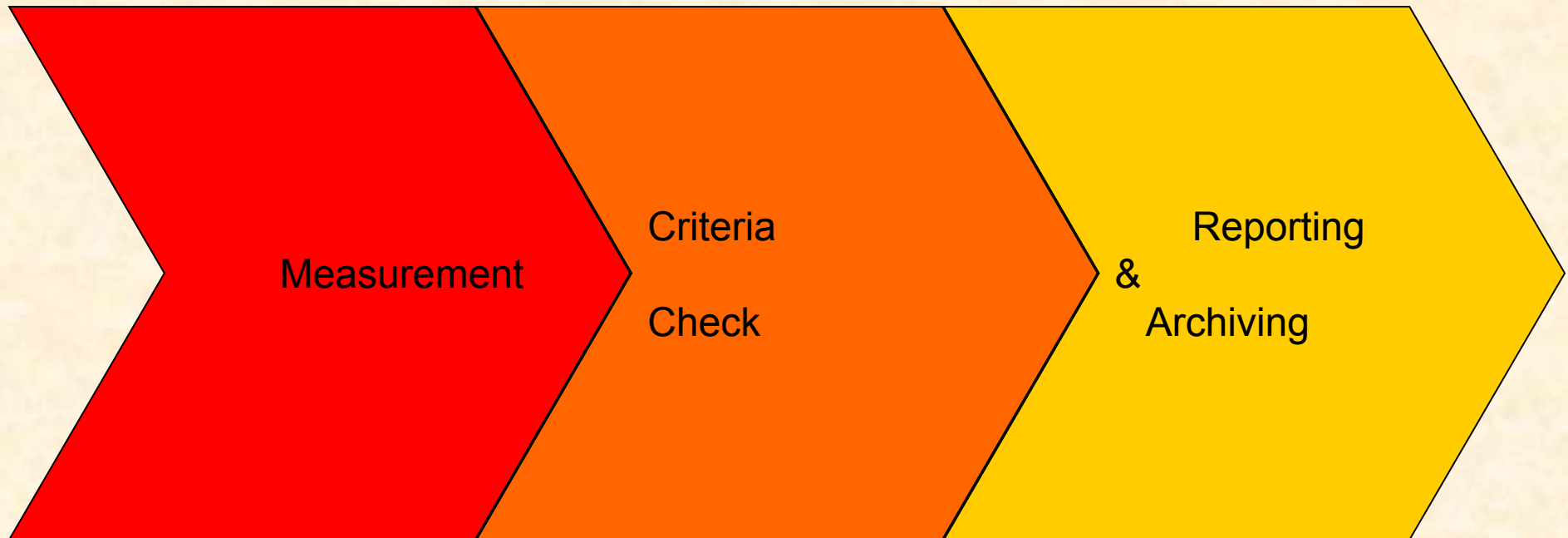
- Diagnostic Process, more than a measurement
- Simple Withstand & Monitored Withstand
- Context – isolated tests versus patterns
- Evolving content
- Correlation with Service Performance



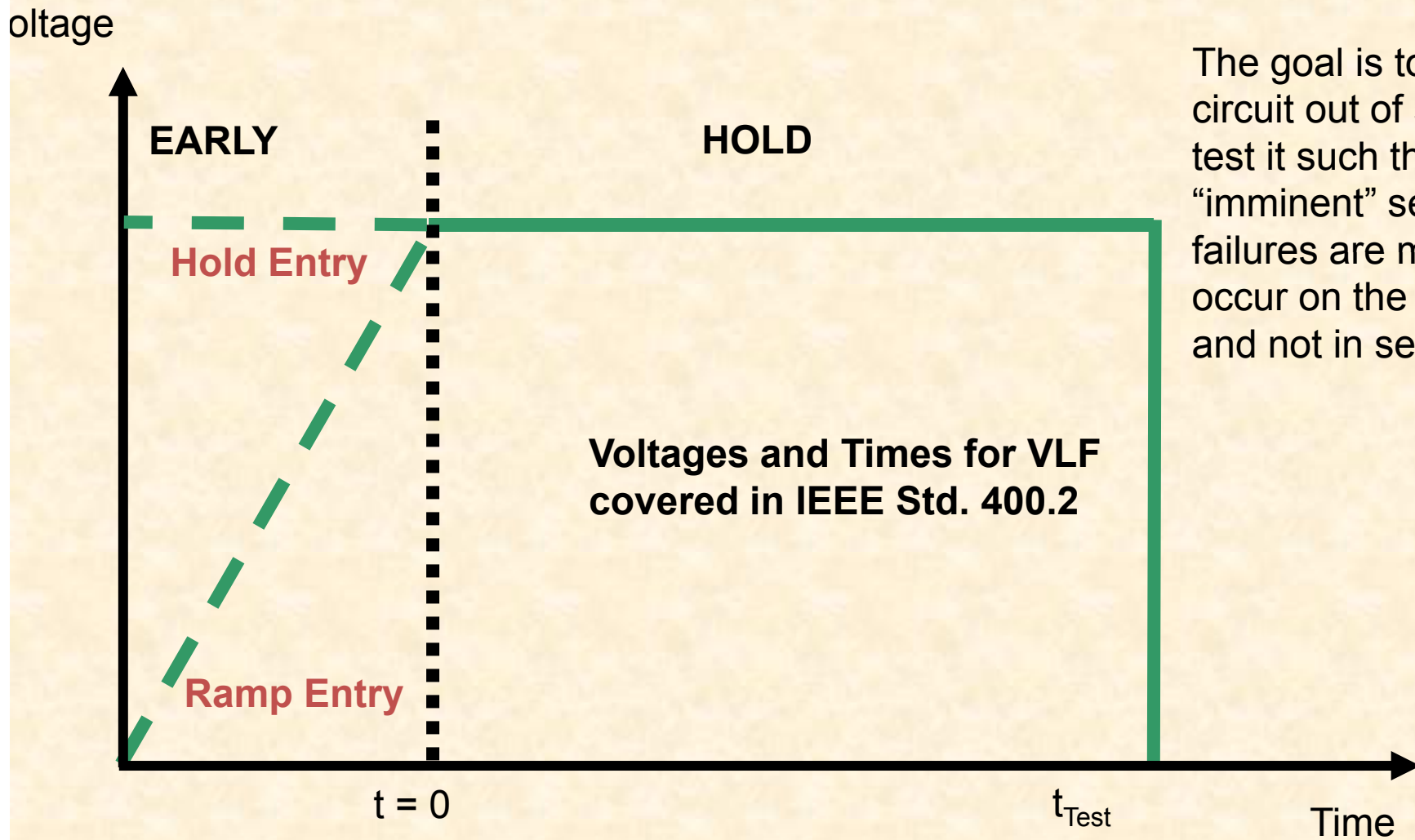
# Many Approaches

- Withstand
- Dielectric Loss
- Leakage
- Monitored Withstand

# What is the Diagnostic Process



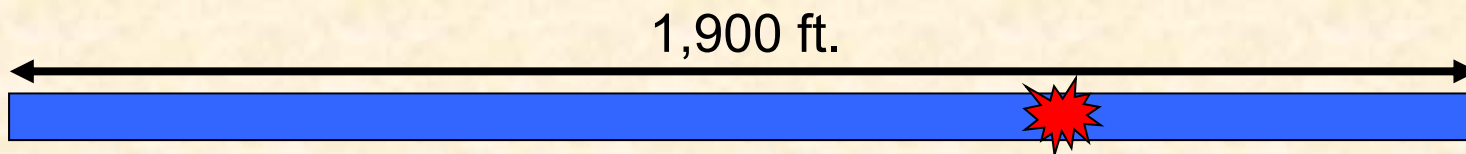
# Withstand Test Process



The goal is to have circuit out of service, test it such that “imminent” service failures are made to occur on the test and not in service

# Length Adjustments

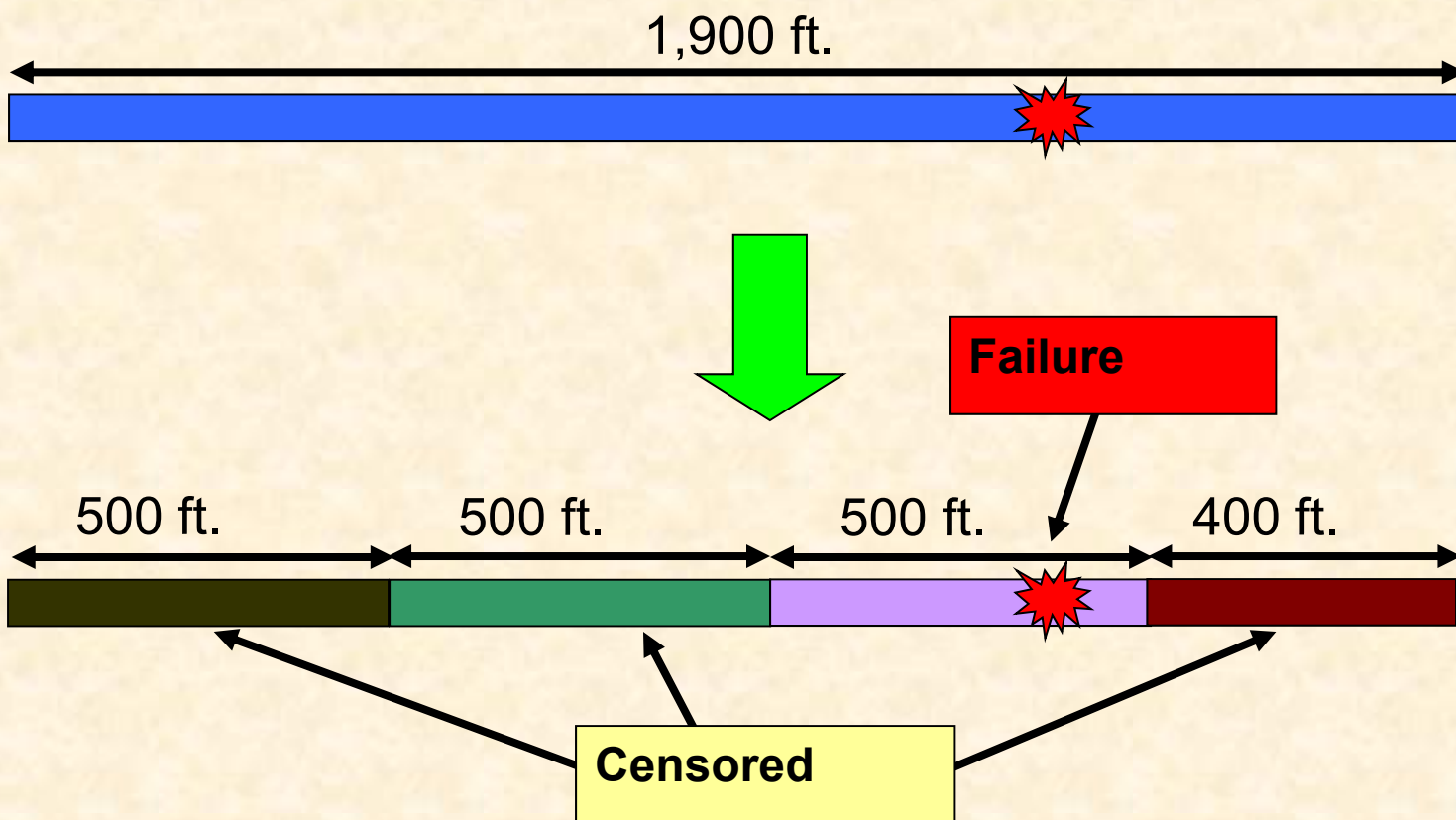
- Comparison of withstand failure on test rates must include length adjustments.



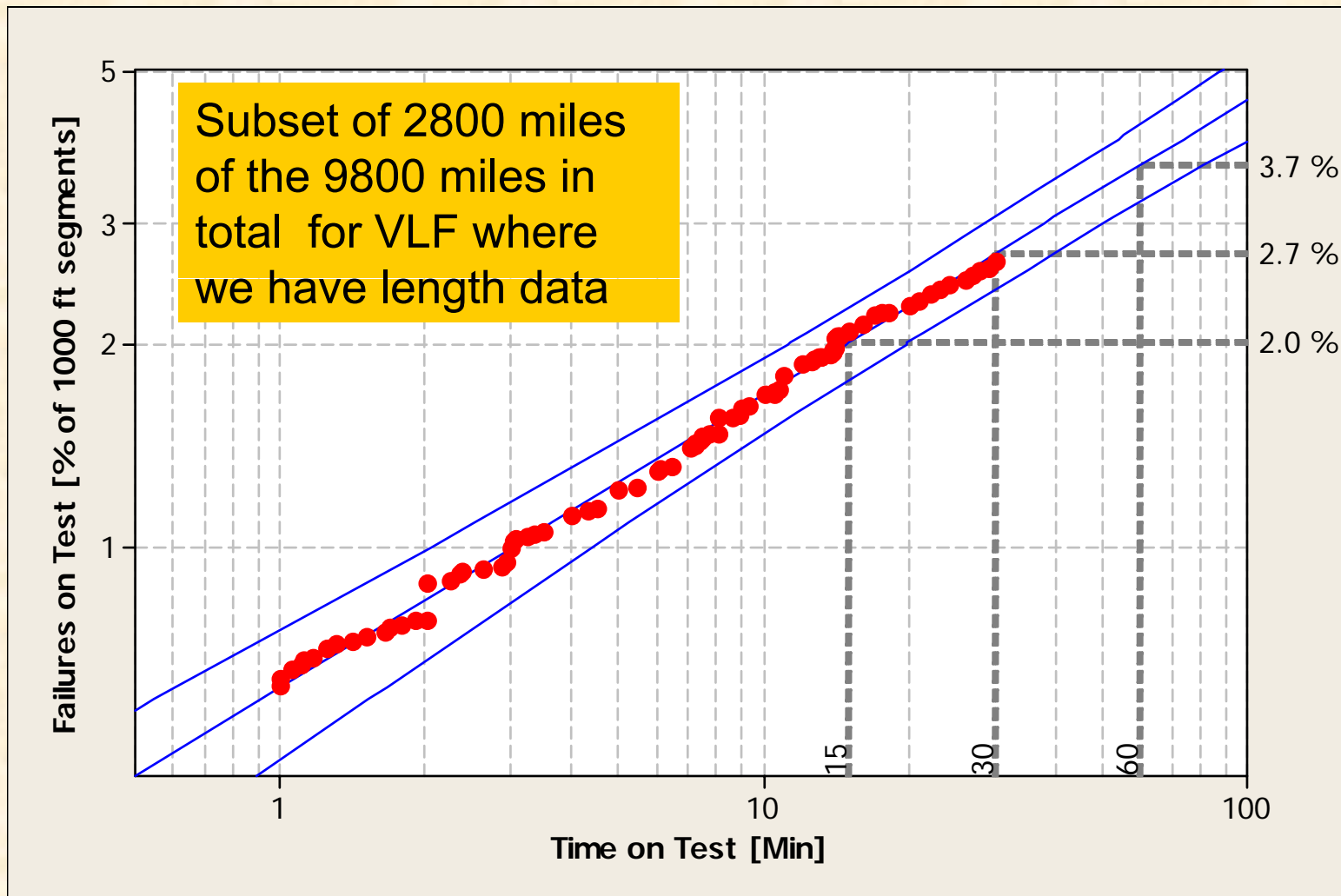
Choose an appropriate base length

# Length Adjustments

- Comparison of withstand failure on test rates must include length adjustments.

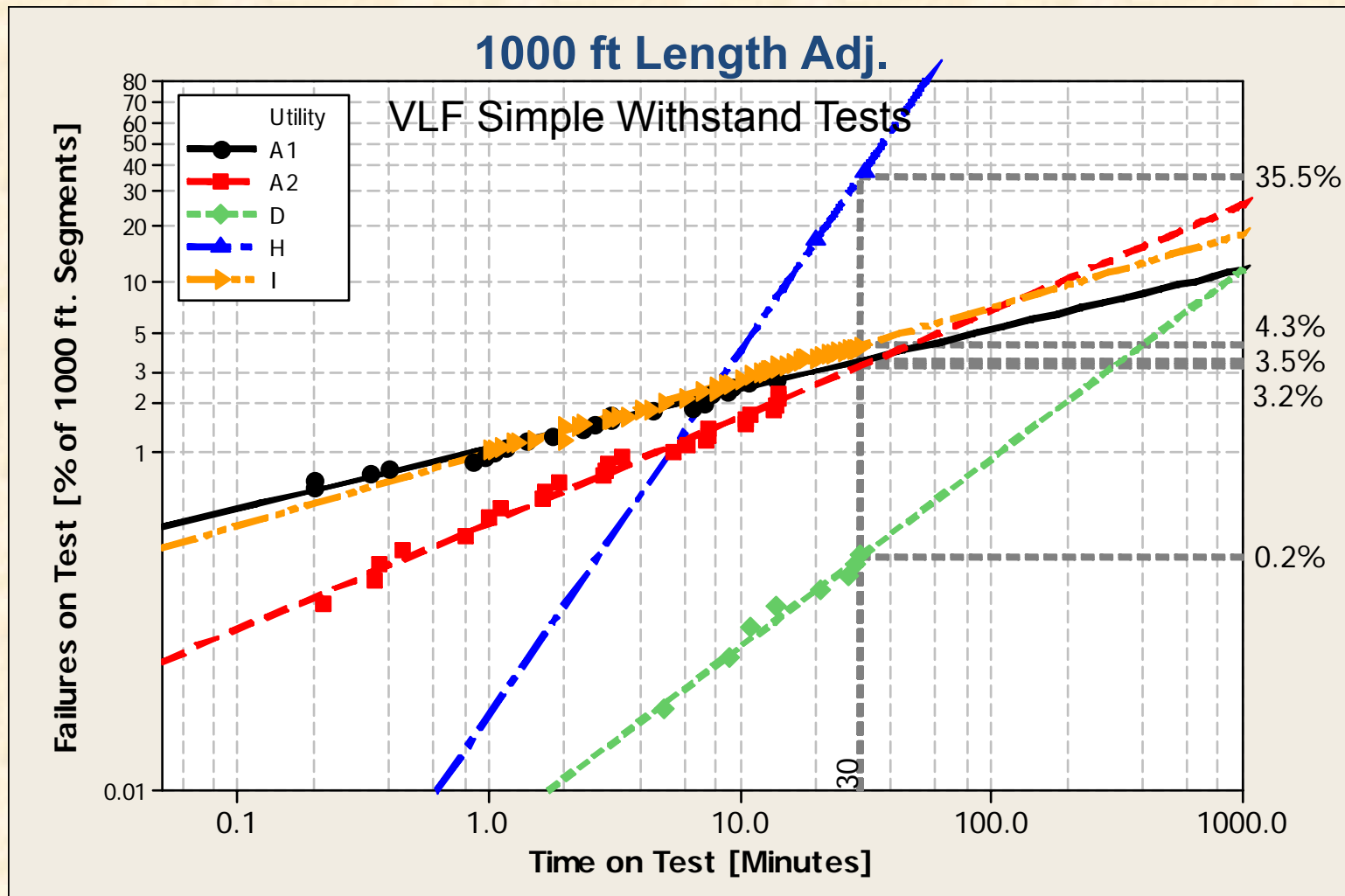


# Collated Experience

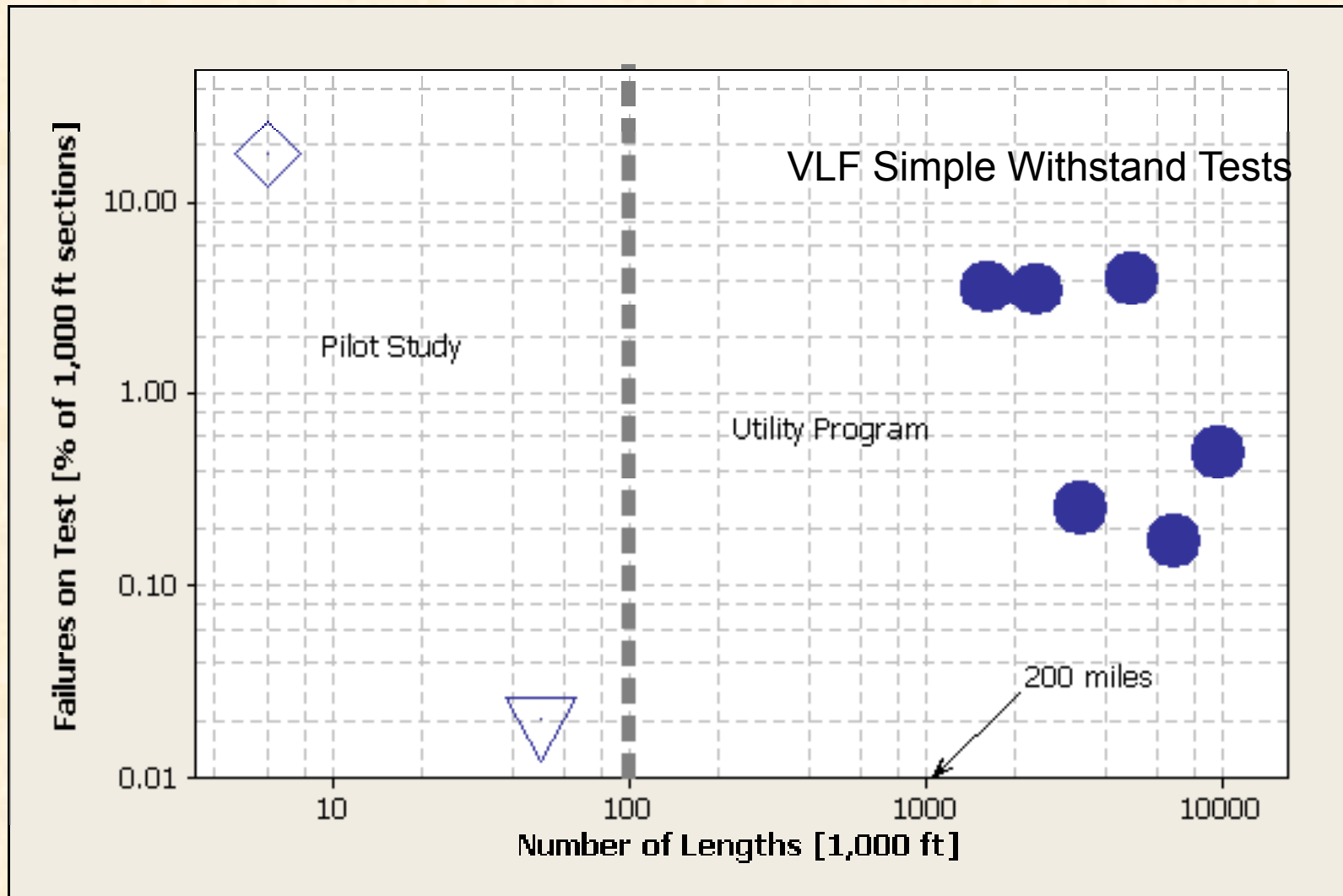




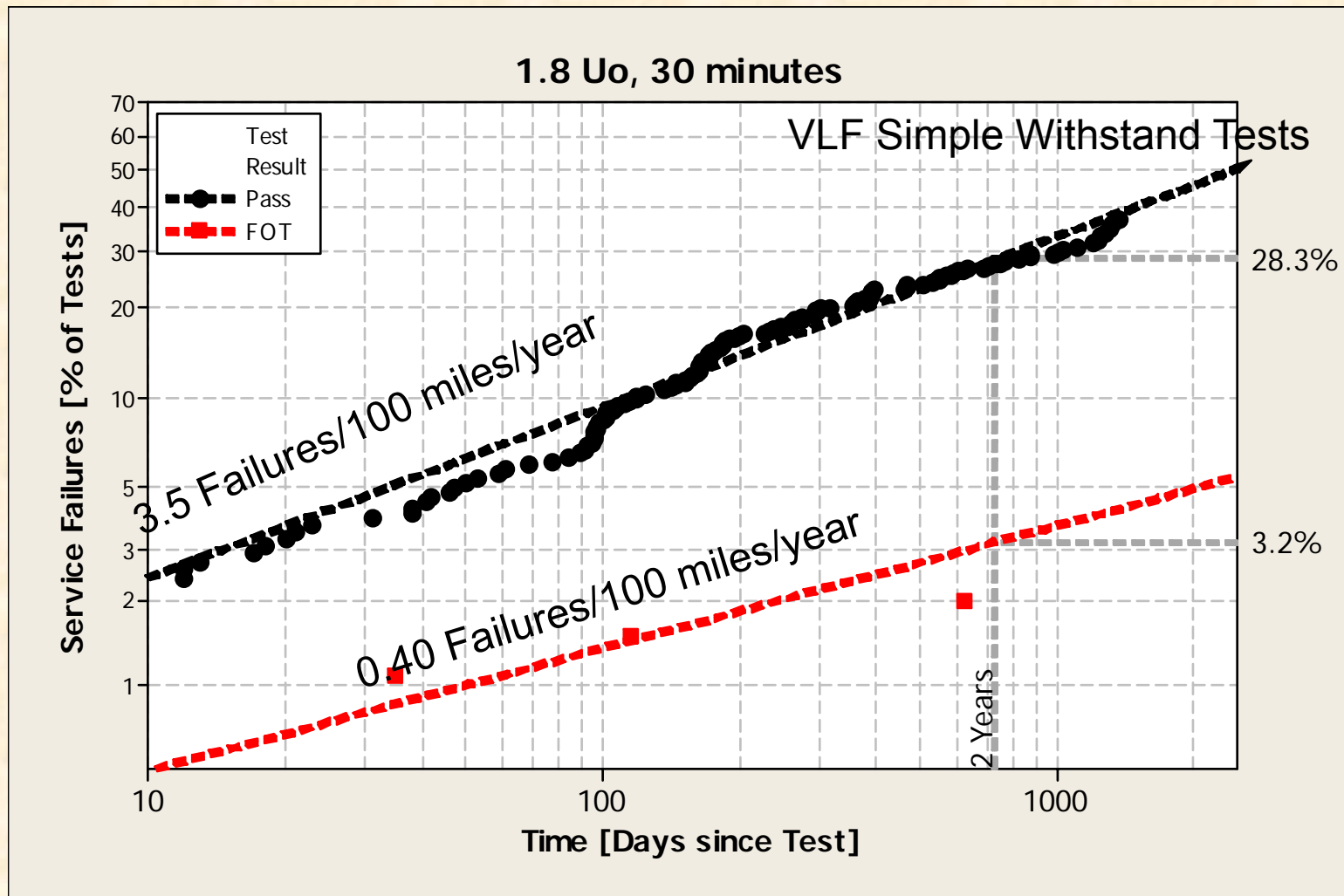
# Test Performance for Different Utilities



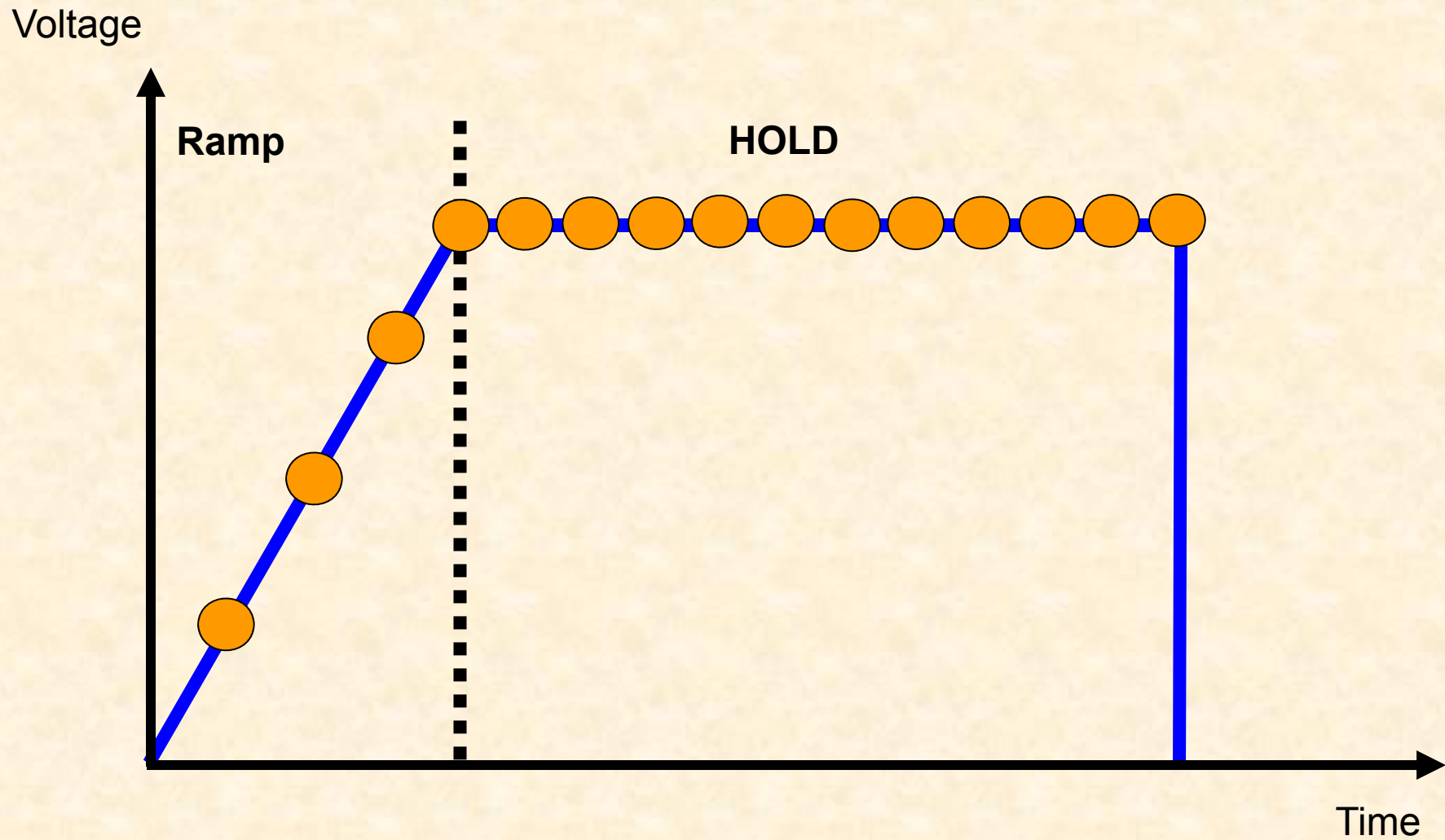
# Care required with experience



# Performance After Test – Pass/No Pass



# Monitored Withstand Test Protocol



# Ways Not to Pass a Monitored Withstand

Failure – Insulation puncture

**OR**

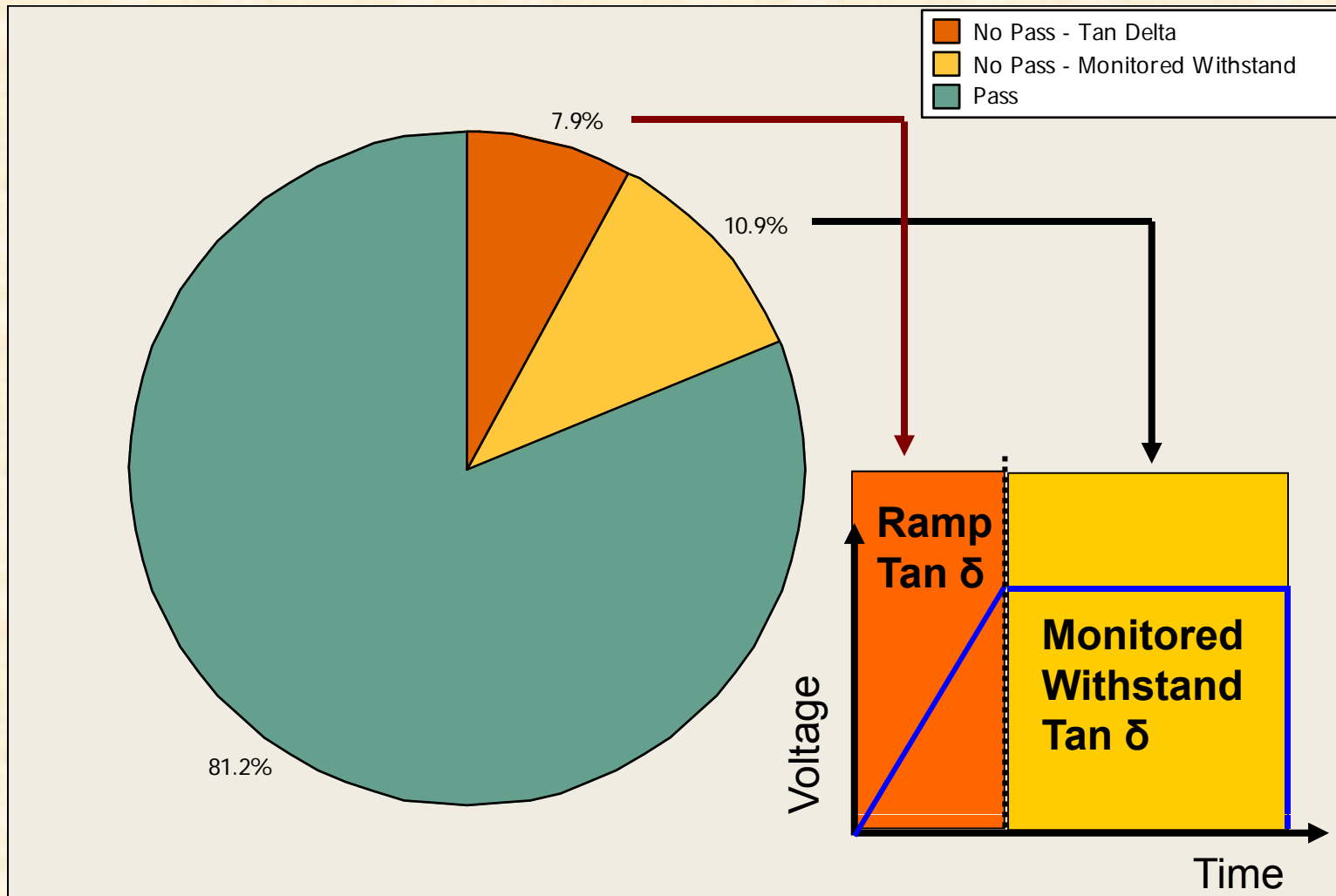
High Dielectric Loss

**OR**

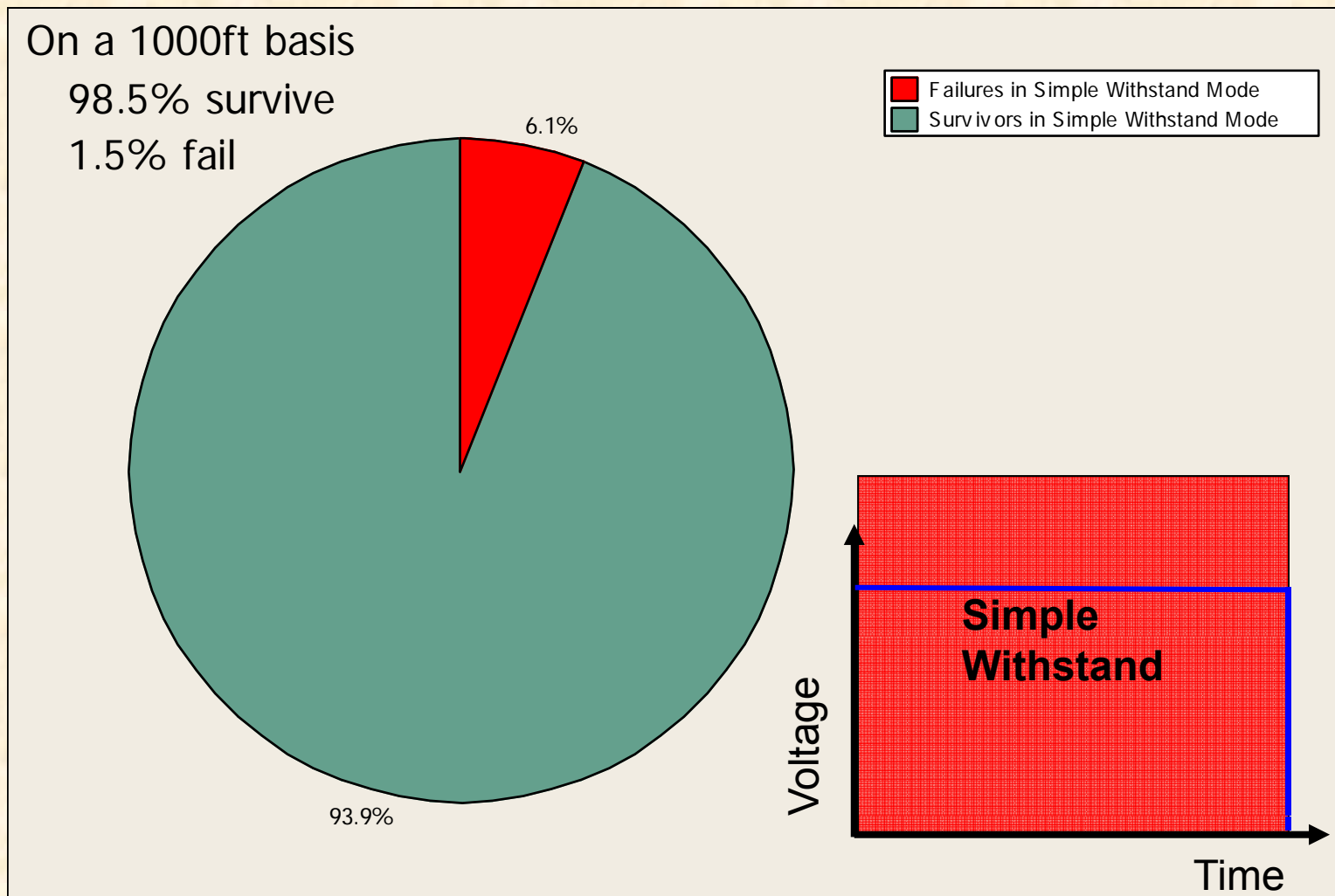
High Instability – Measured by standard deviation in consecutive measurements at one voltage level



# Monitored Withstand Results

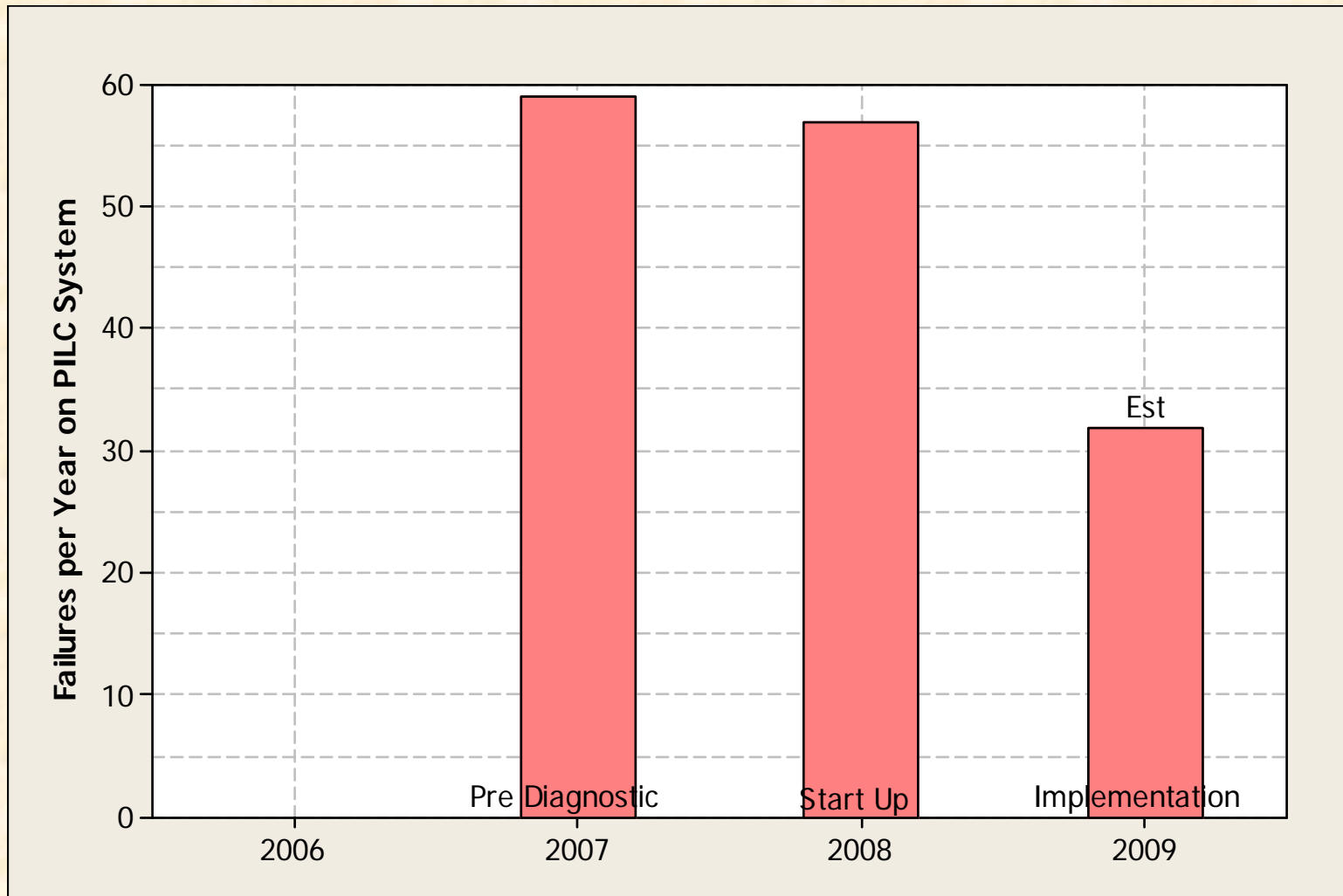


# Simple Withstand Results





# Failures



# Monitored Withstand

- VLF & Tan Delta

- Ramp

- Stability – Std Dev
- Tip Up
- Level

- Hold

- Trend – Size, Slope
- Stability – Std Dev
- Level

- VLF & UWB PD

- Ramp

- ?

- Hold

- ?

? = Magnitude,  
Inception, t/F Map  
Coordinates, Features,  
Location

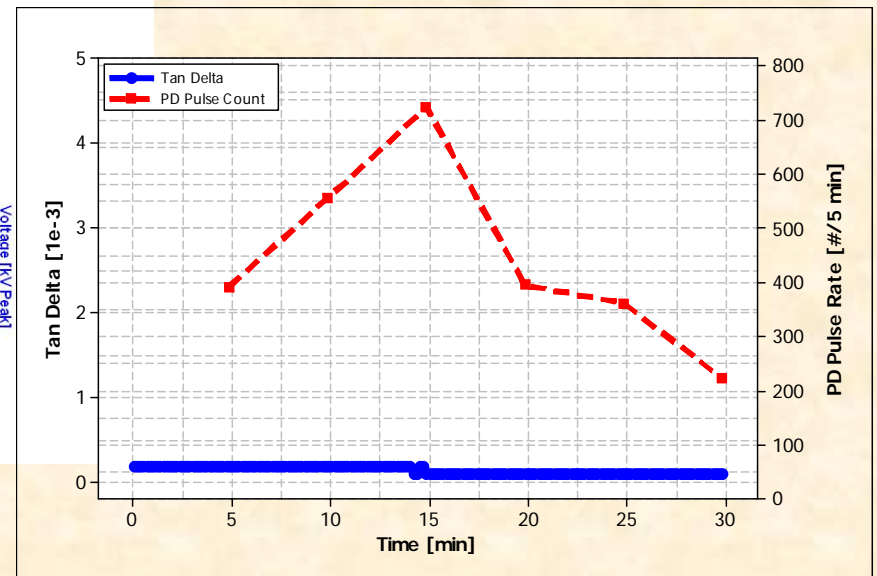
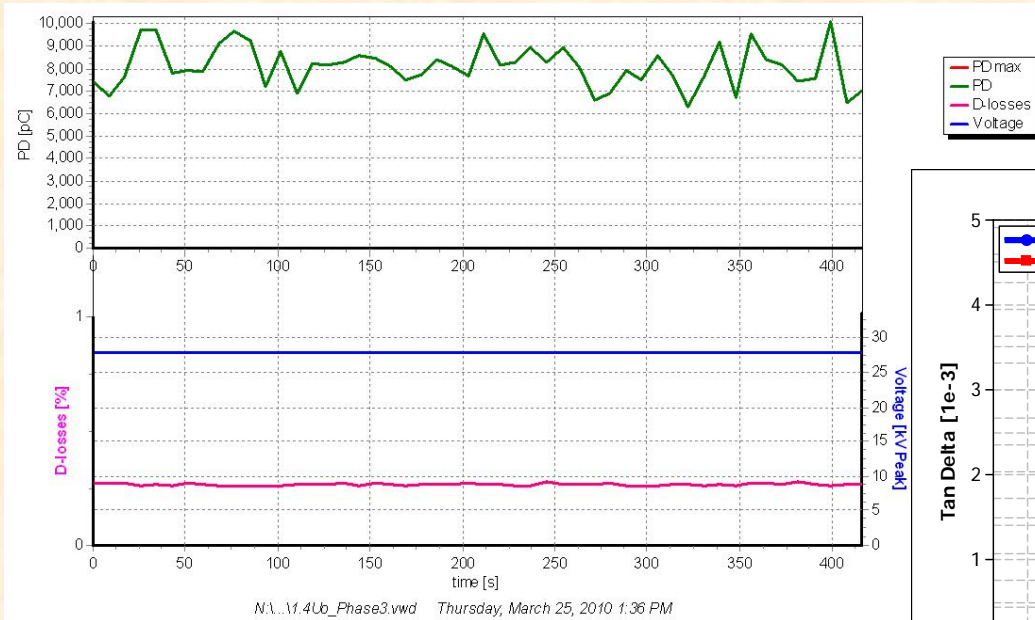
# Combined Diagnostics - Monitoring

- DAC

- UWB PD
- Dielectric Loss

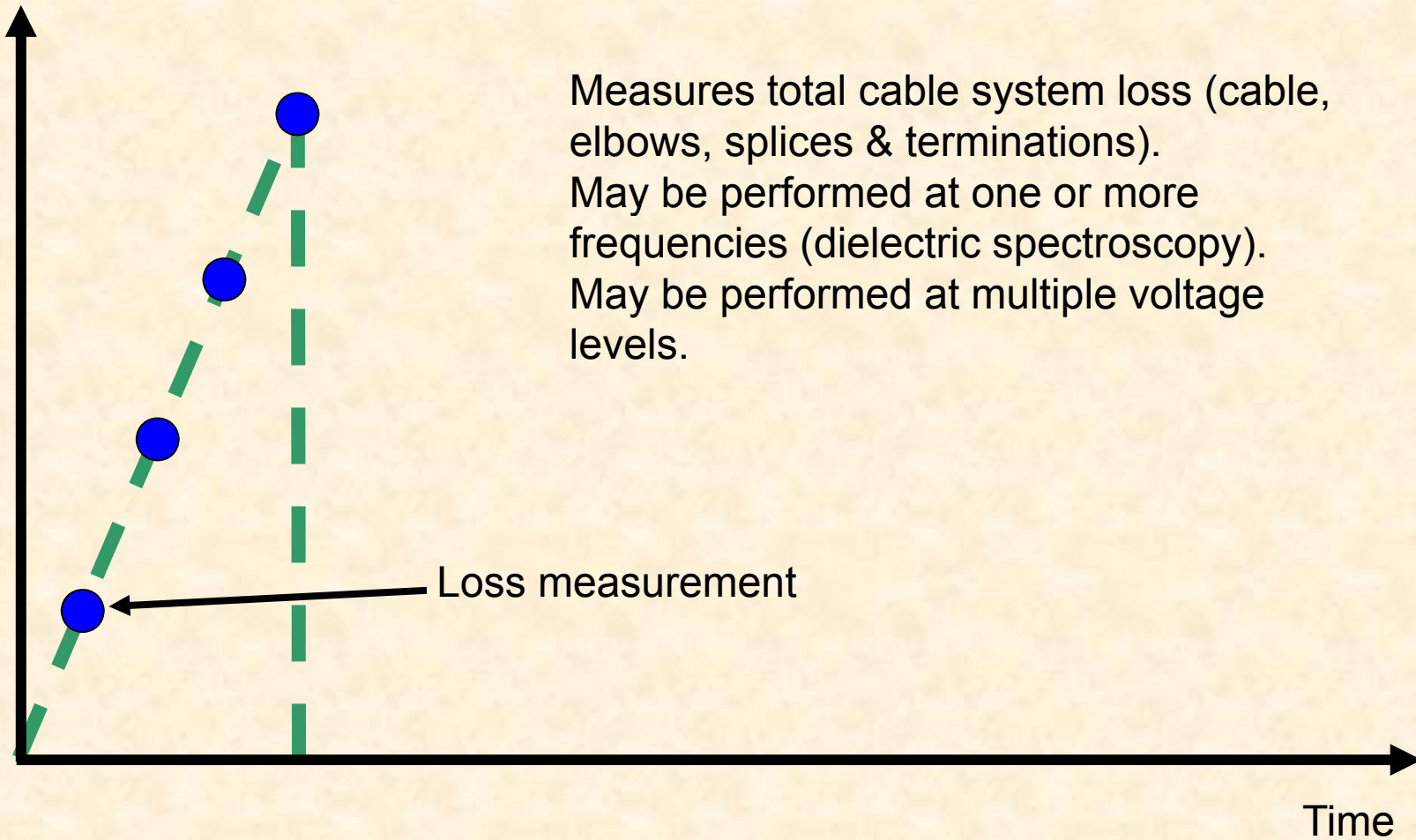
- VLF

- Tan Delta
- UWB PD

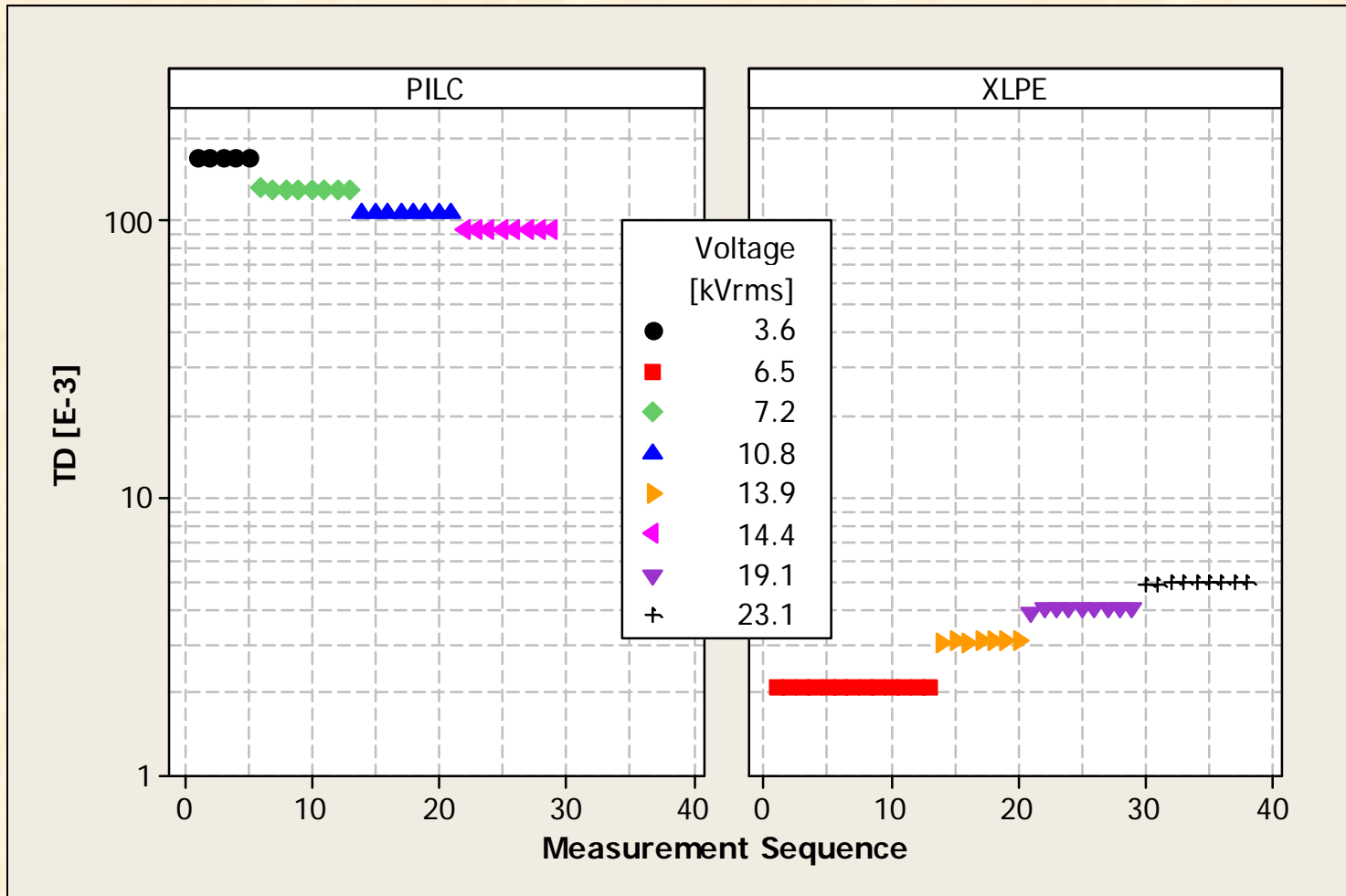


# Dielectric Loss Test Process

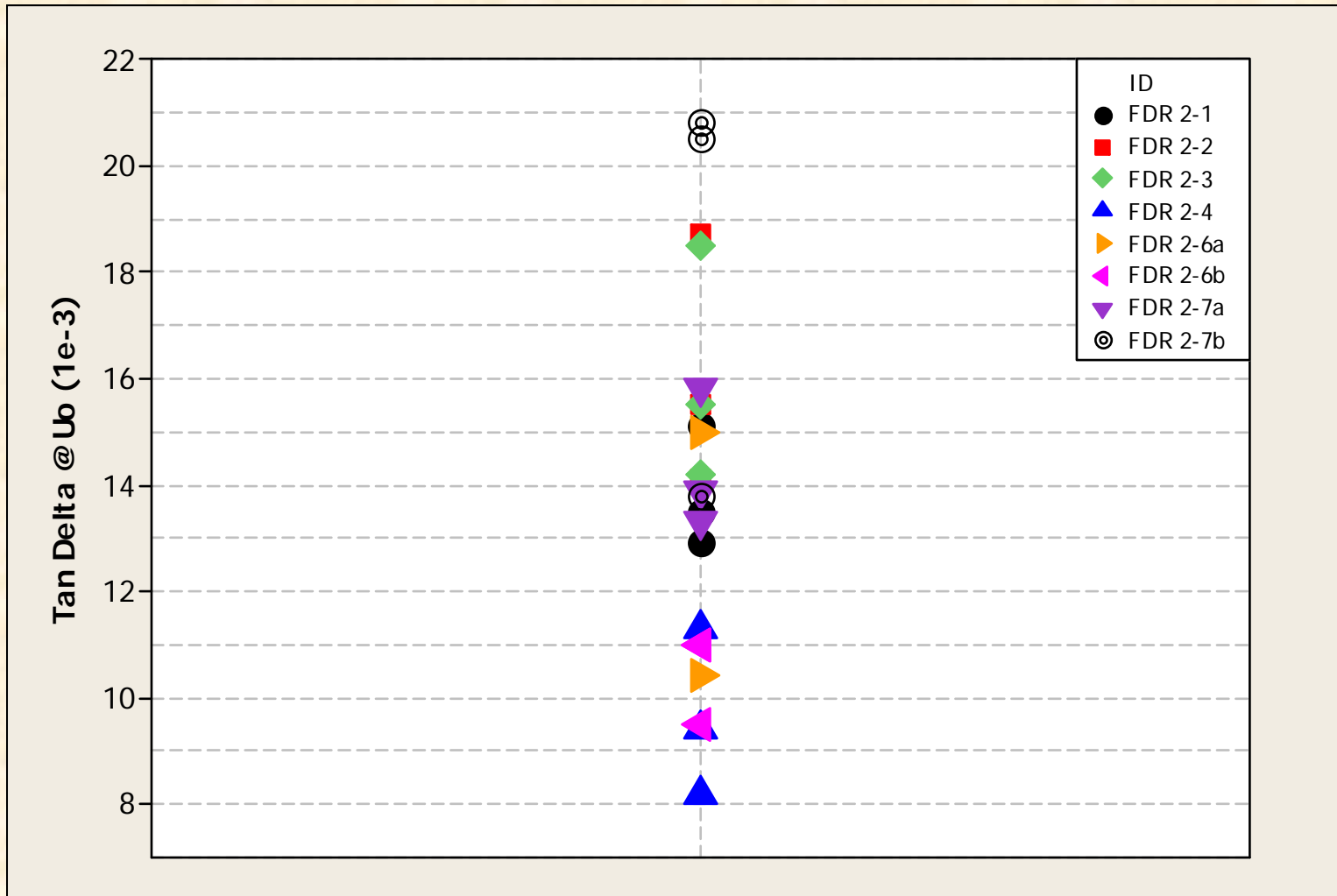
voltage



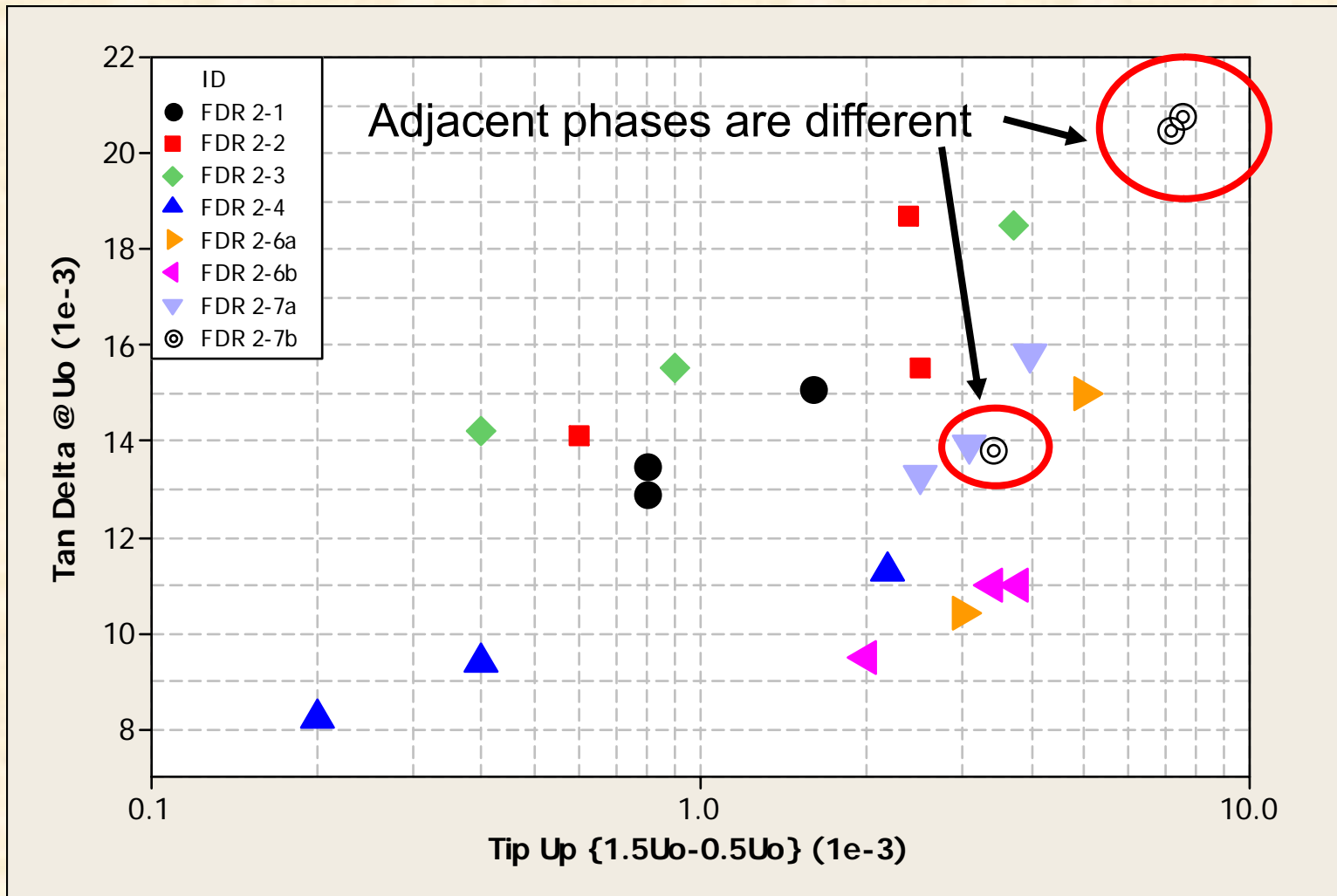
# Measured Tan $\delta$ data from Cable Systems



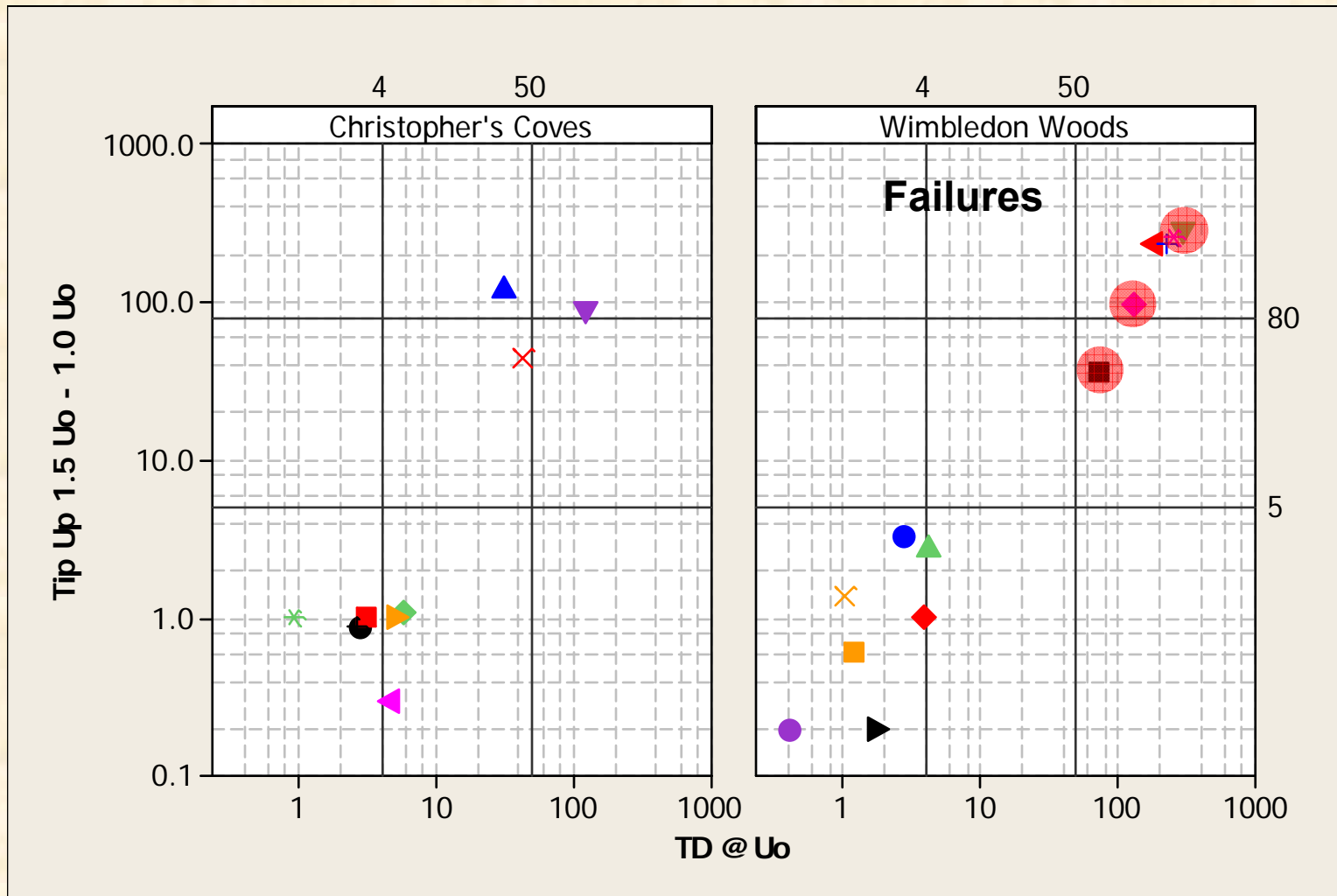
# Tan $\delta$ at $U_0$



# Tan $\delta$ and Tip Up Map

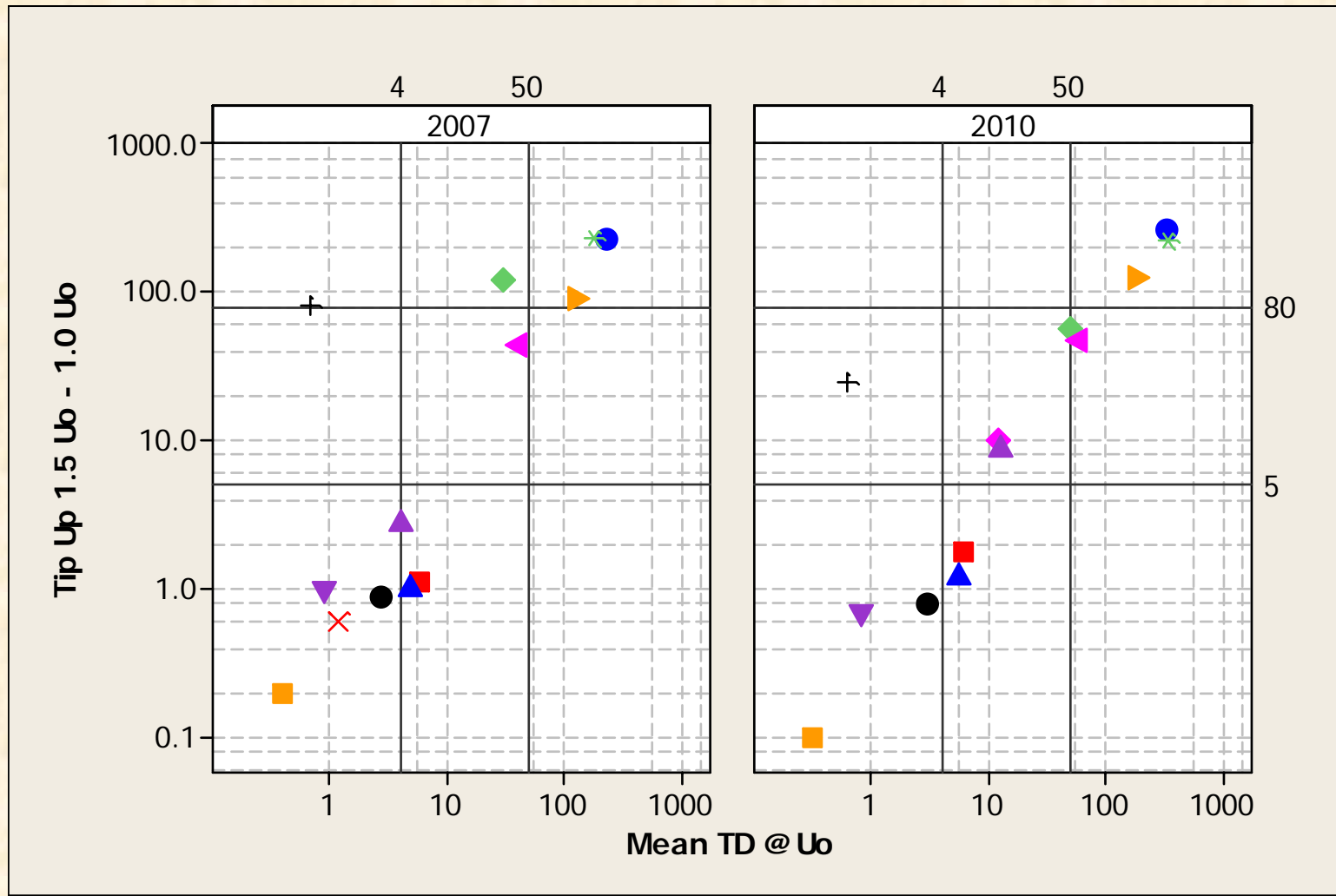


# Jacketed & Unjacketed XLPE Data- 2007

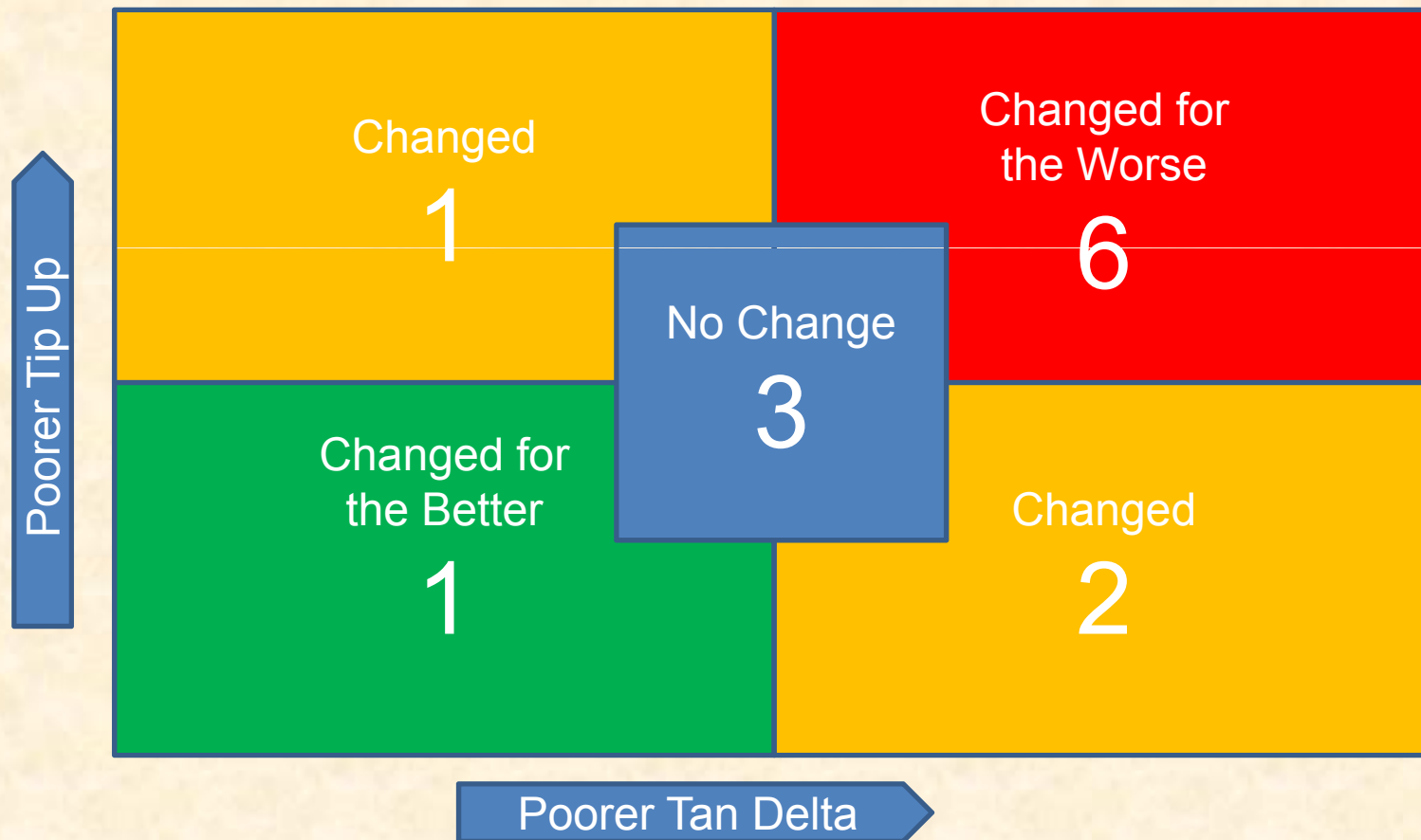




# 2010 versus 2007 Results

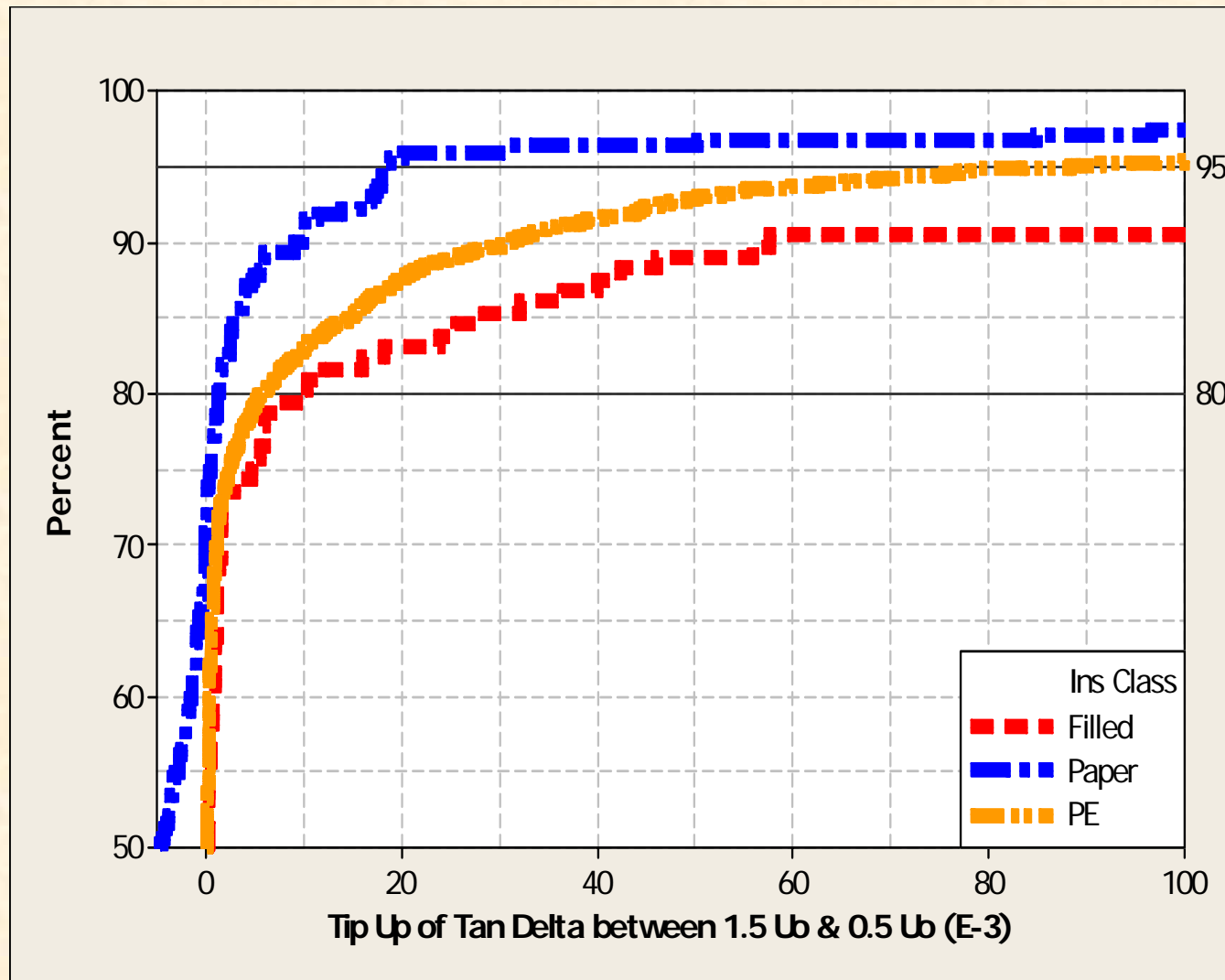


# Jacketed & Unjacketed Data



Three "Action Required" failed before testing in 2010

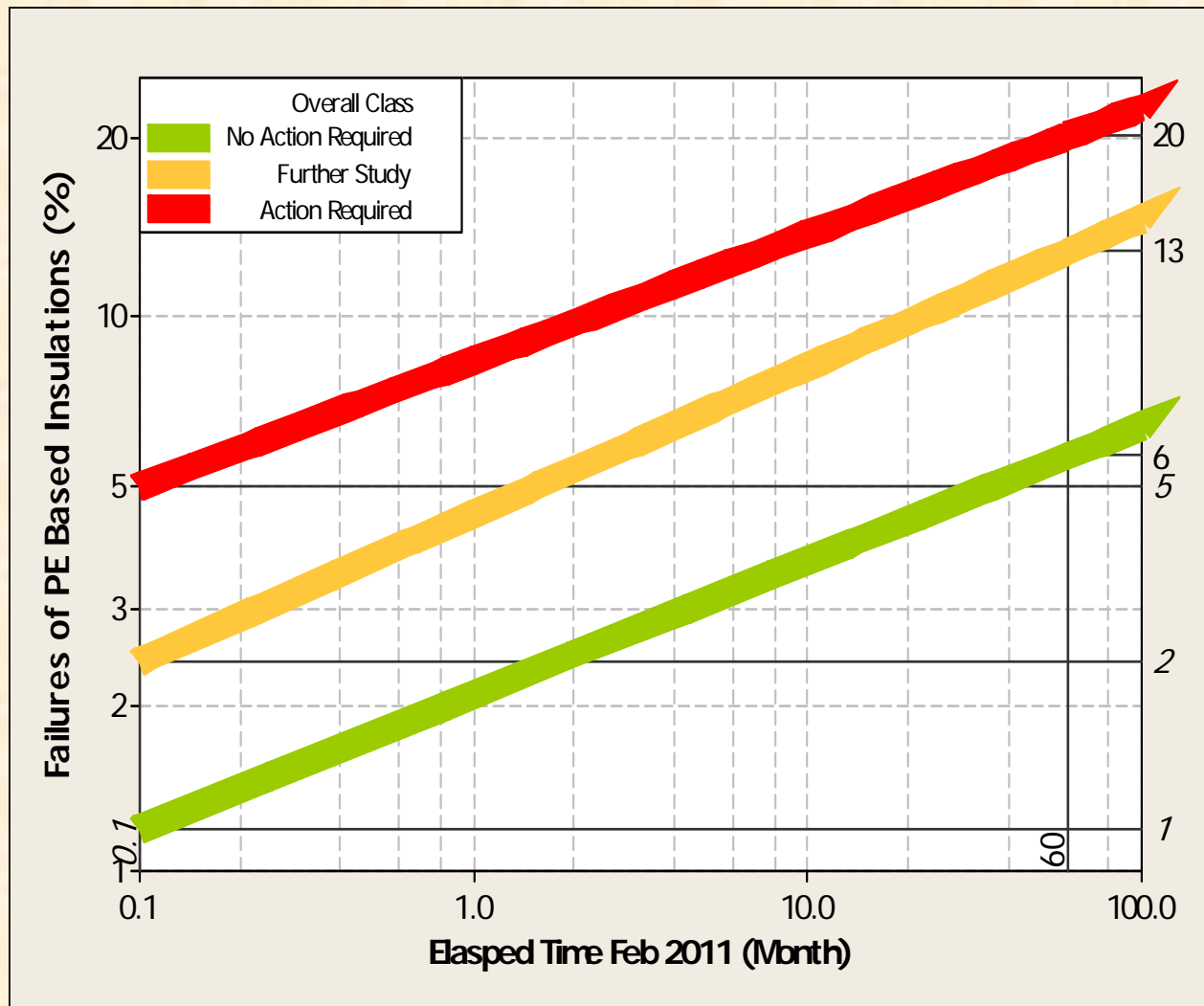
# Criteria



Assumption of “unusualness” based on the 80th & 95<sup>th</sup> percentiles

Evolution is sensitive to the acquisition of new data – especially data on poorly performing circuits

# Relationship to Performance in Service



PE  
based  
cables

# Problems in the Monitor Phase

- Requires time – you cant implement your diagnostic straight out of the box
- Requires utility discipline
  - Accurate monitoring and communication in the field
  - Hands Off approach
- Requires that you get the selection correct
  - The area has to be bad enough
  - You have to have enough
  - Sufficient diversity

# Some general reflections

1. A database of field failure diagnostic data shows that diagnostic techniques can provide useful.
2. Diagnostic results can be imprecise, diagnostic are generally beneficial.
3. Benefits can generally be quantified, but takes time and effort.
4. HAVE to act on ALL replacement/repair recommendations to get improvements.
5. It is difficult to predict whether or not the problems/defects detected by PD or Tan  $\delta$  will lead to failure.
6. Tan  $\delta$  & PD measurements require interpretation to establish how to act.