

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

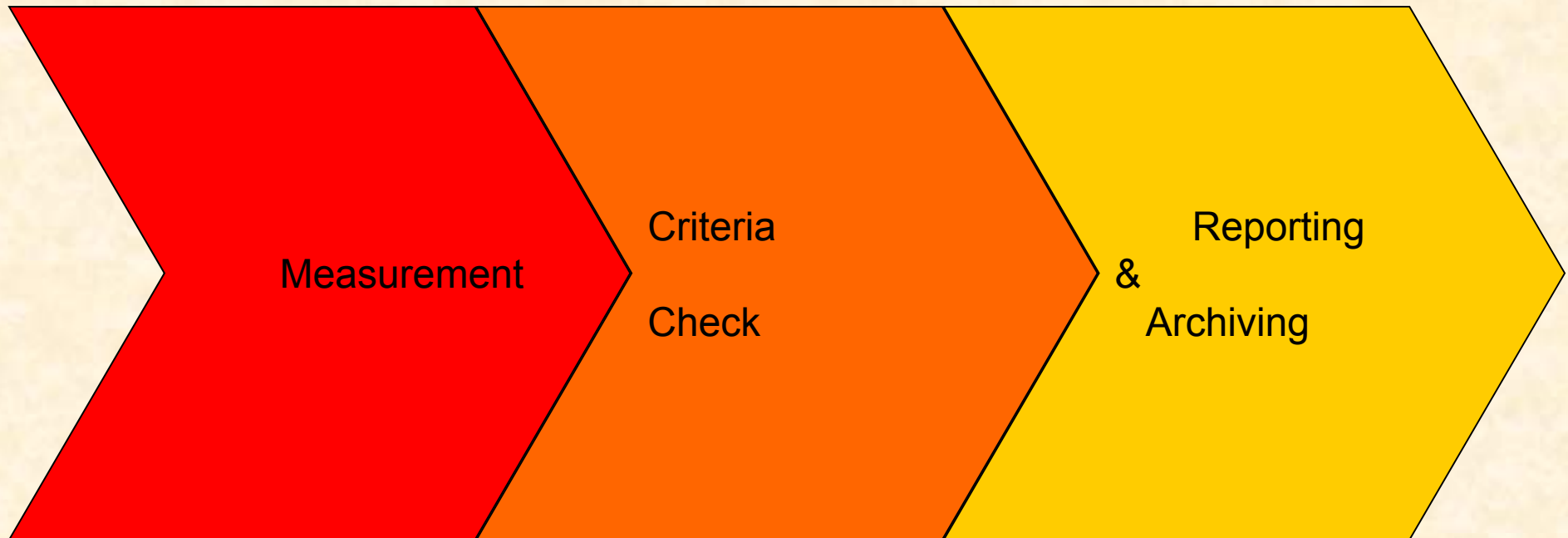
- Diagnostic Process, more than a measurement
- Simple Withstand & Monitored Withstand
- Context – isolated tests versus patterns
- Evolving content
- Correlation with Service Performance



Many Approaches

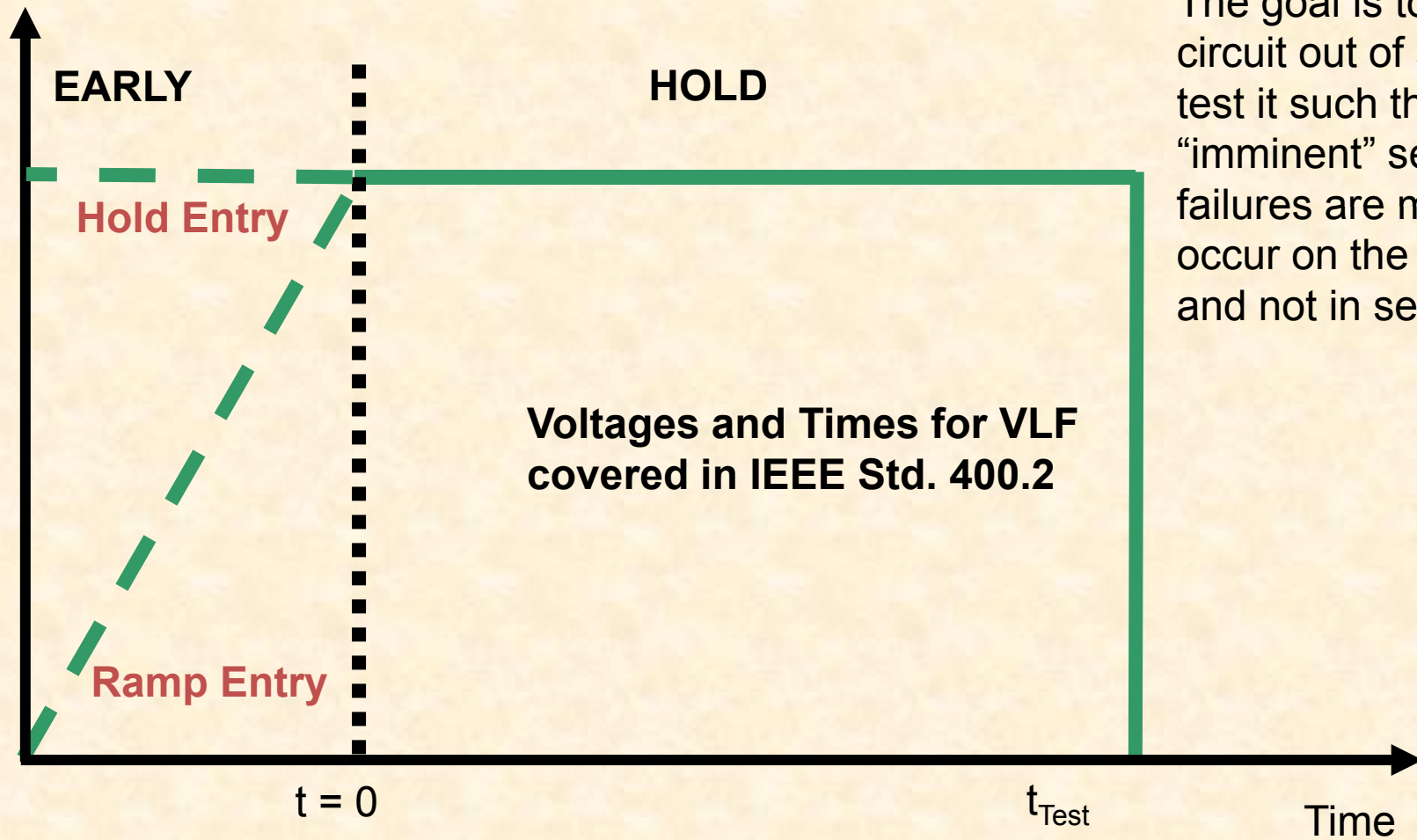
- Withstand
- Dielectric Loss
- Leakage
- Monitored Withstand

What is the Diagnostic Process



Withstand Test Process

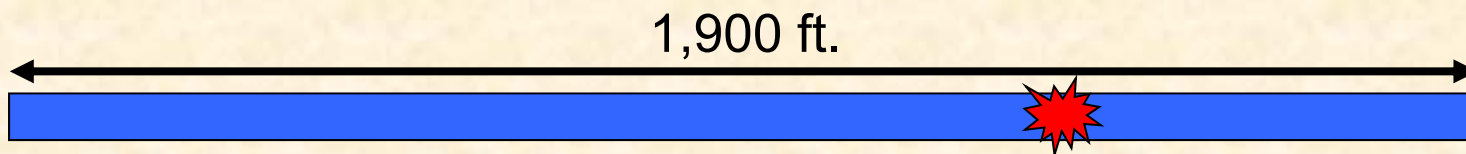
voltage



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

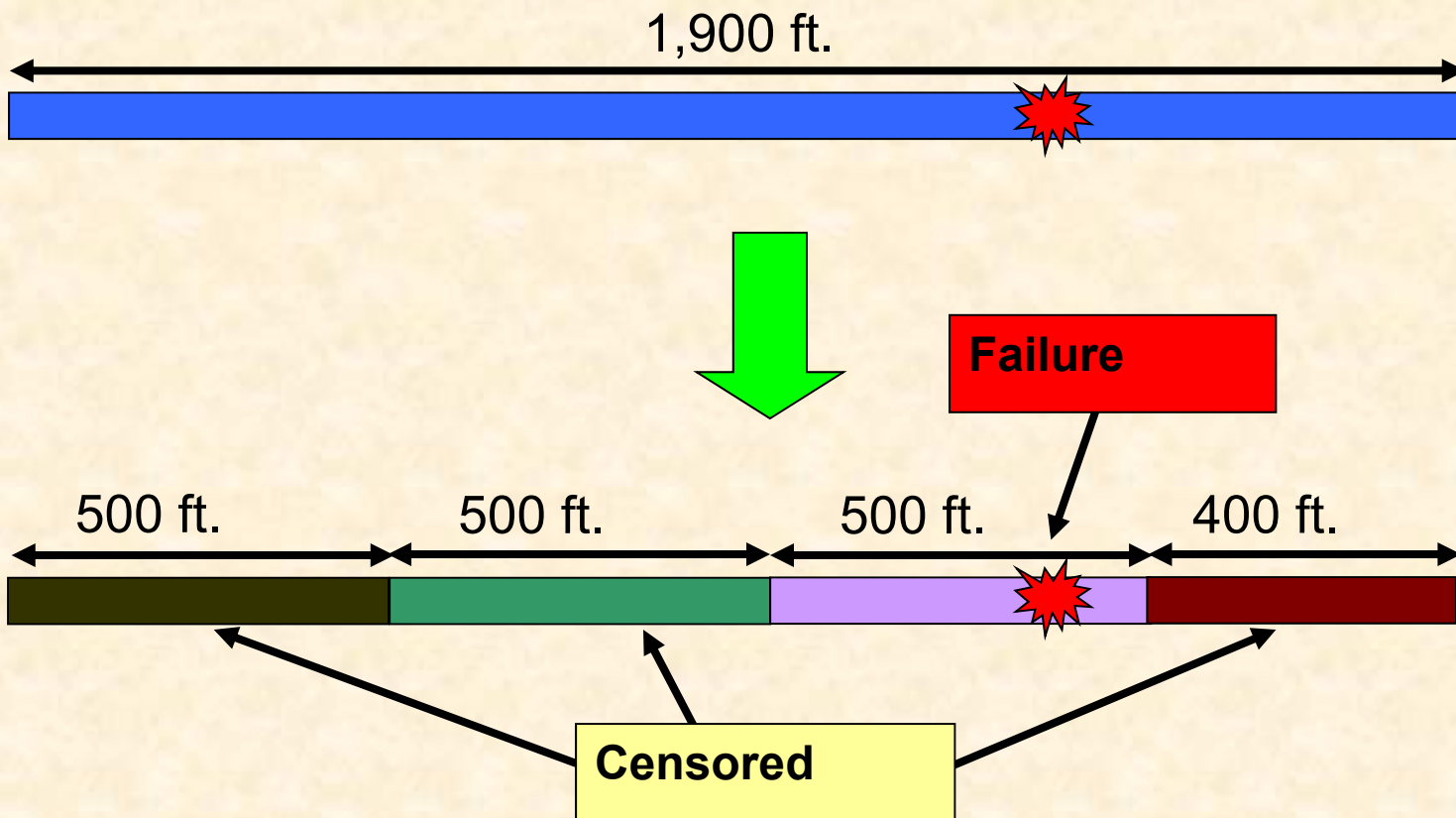
- Comparison of withstand failure on test rates must include length adjustments.



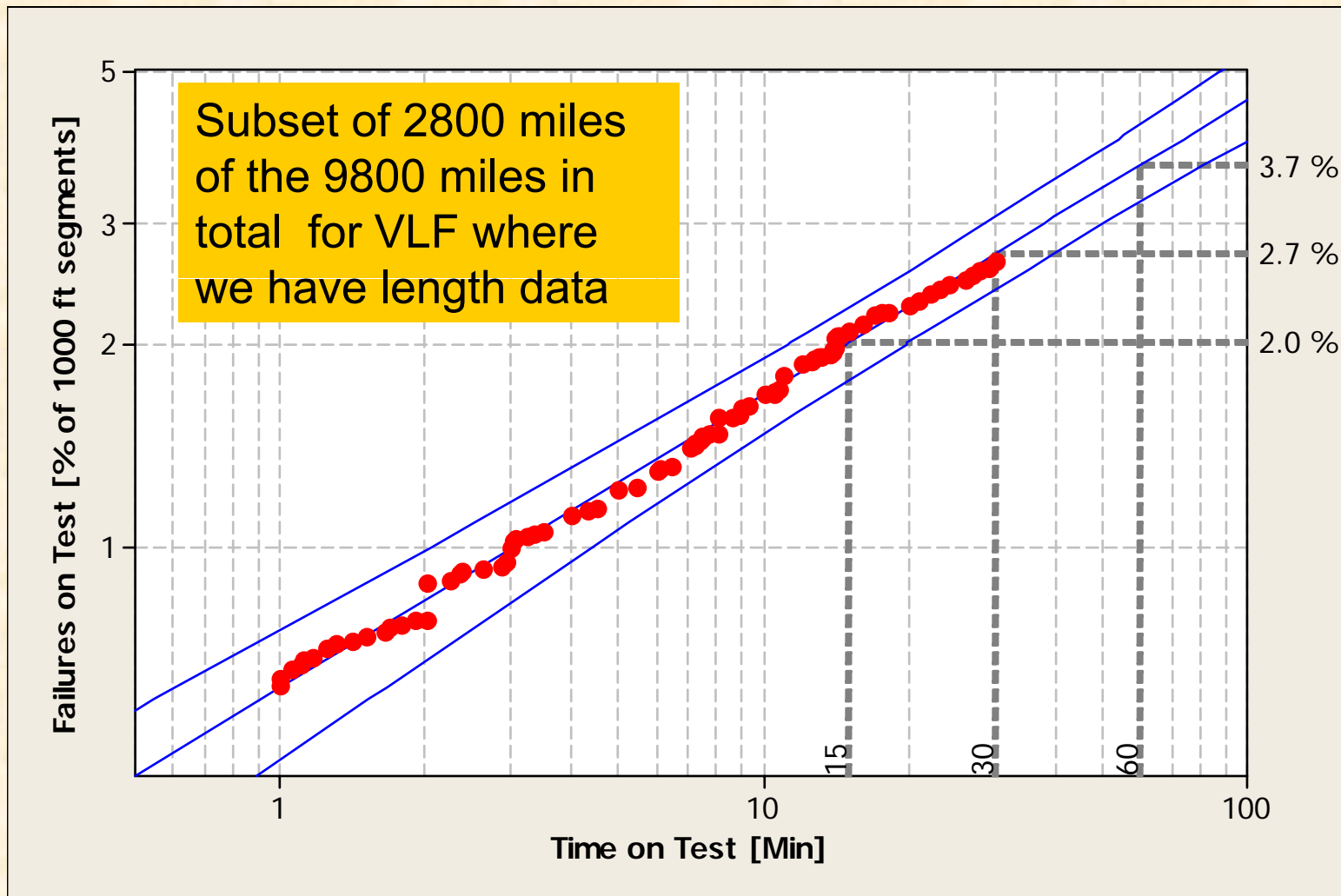
Choose an appropriate base length

Length Adjustments

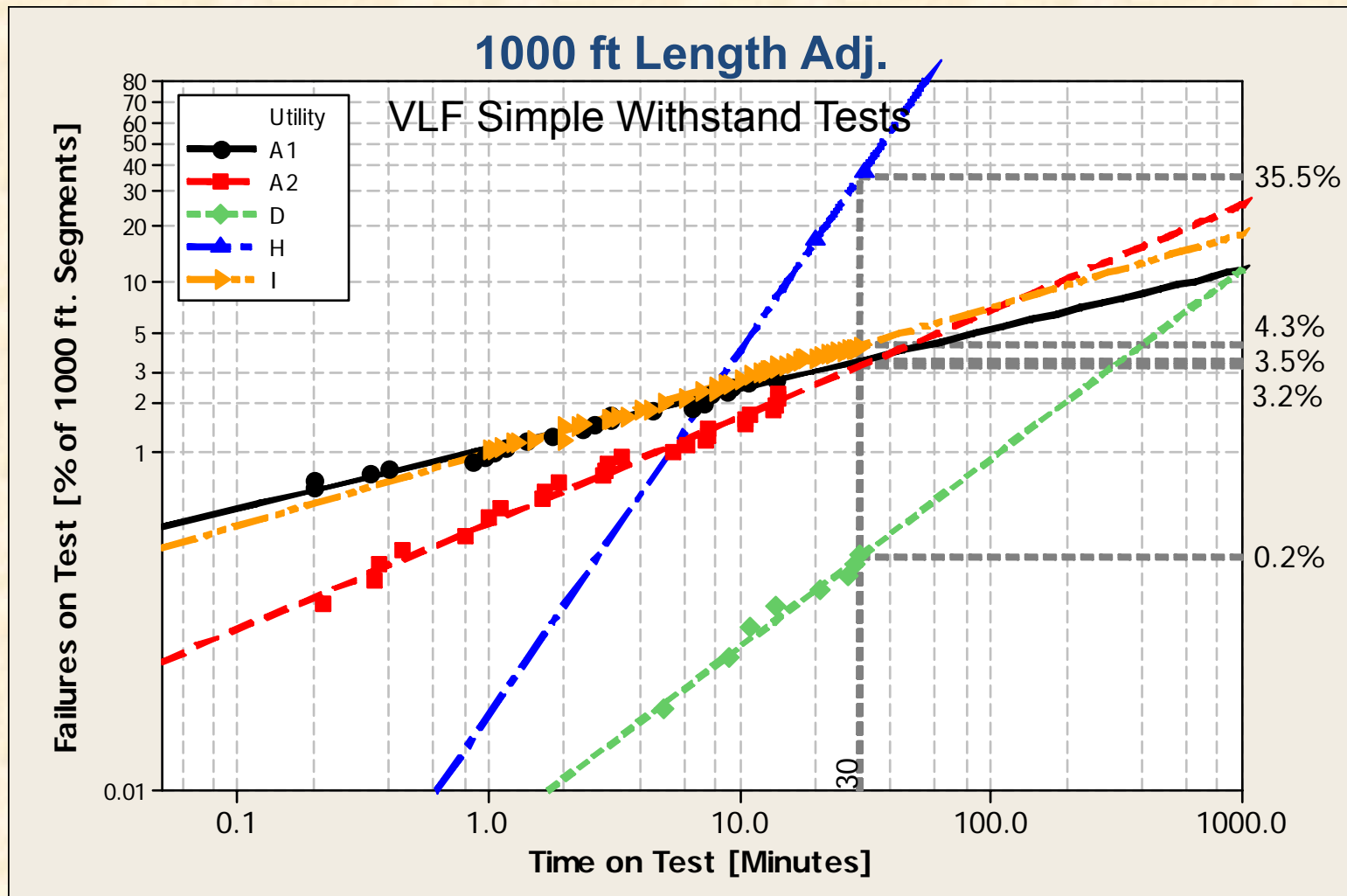
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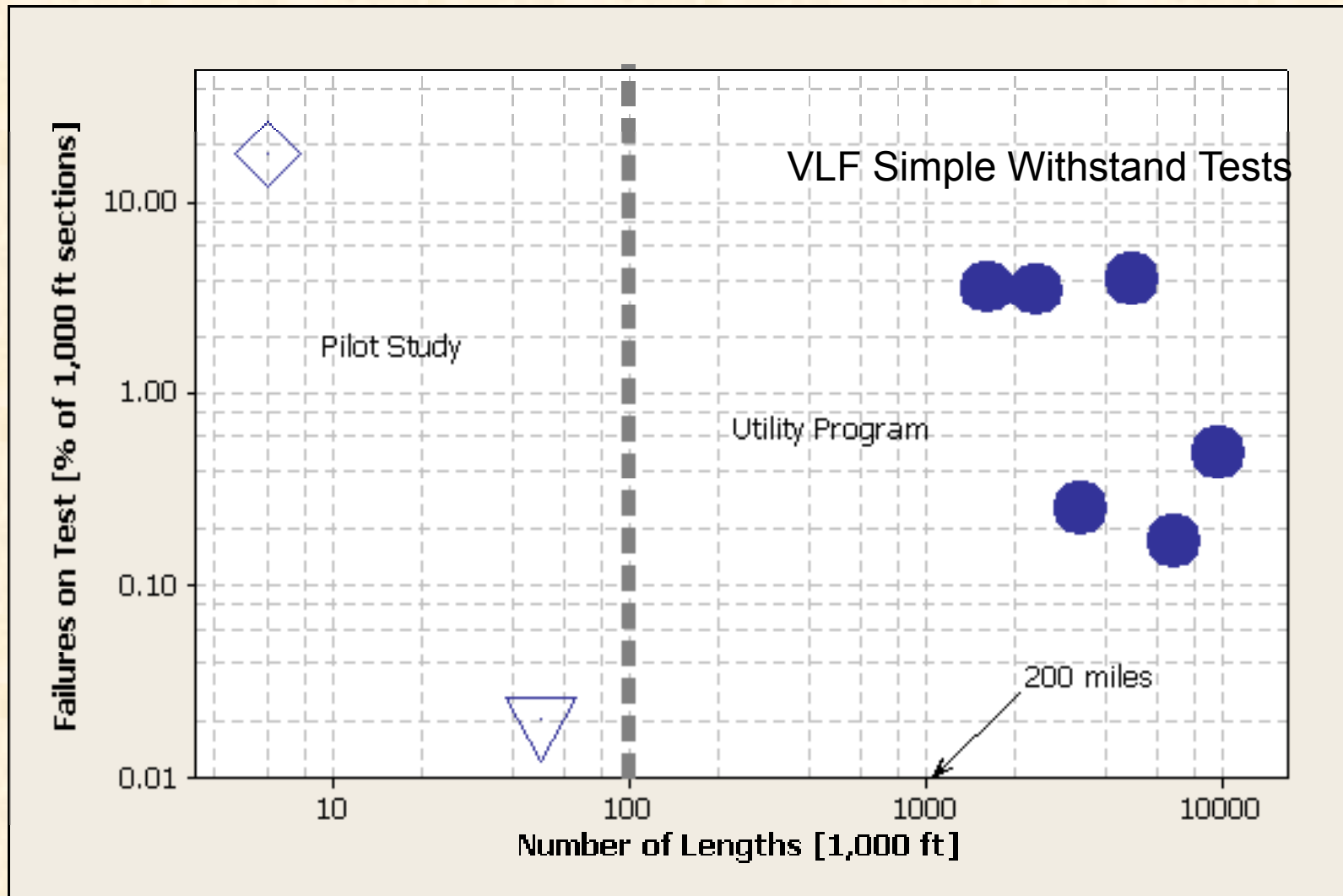
Collated Experience



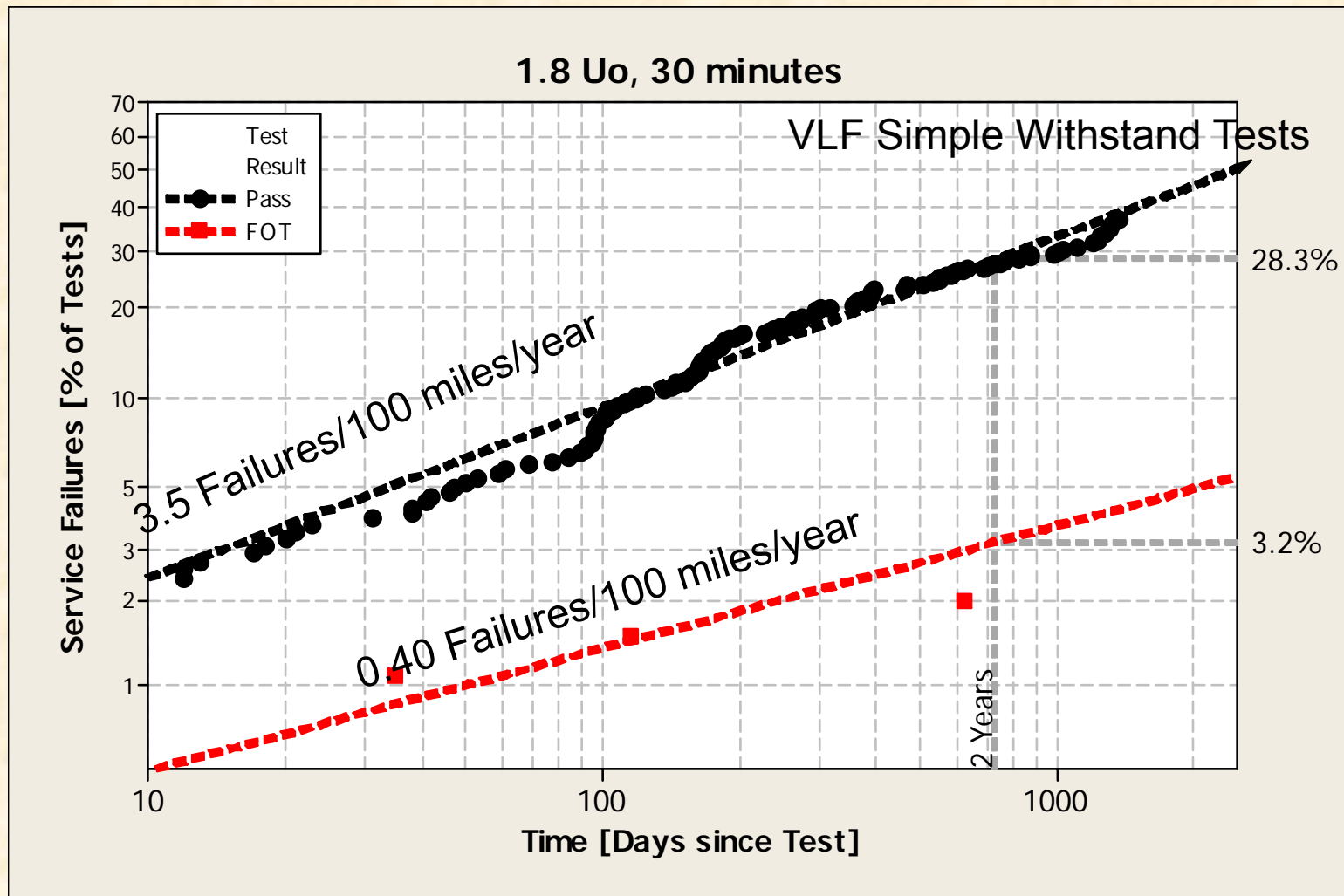
Test Performance for Different Utilities



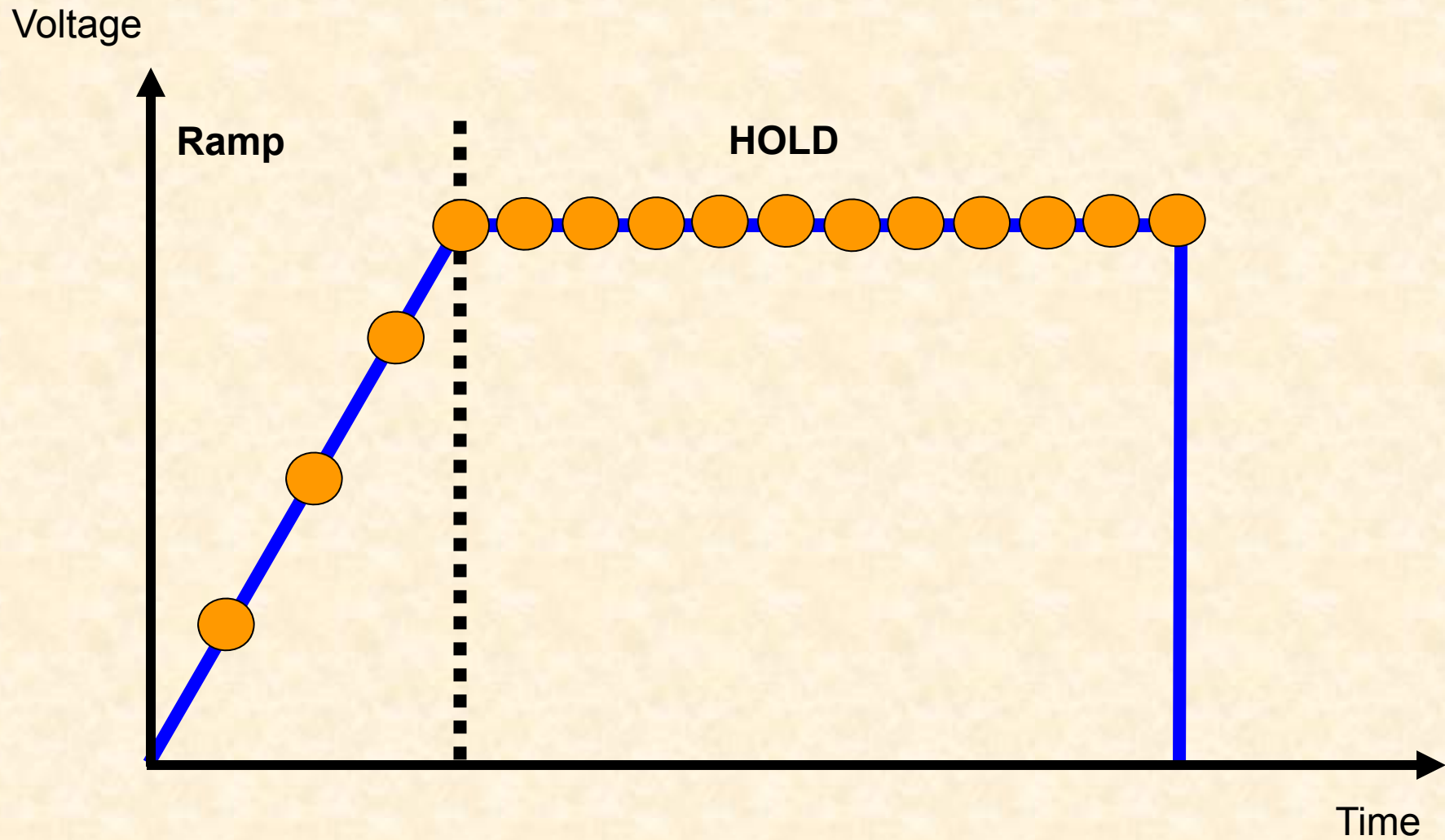
Care required with experience



Performance After Test – Pass/No Pass



Monitored Withstand Test Protocol



Ways Not to Pass a Monitored Withstand

Failure – Insulation puncture

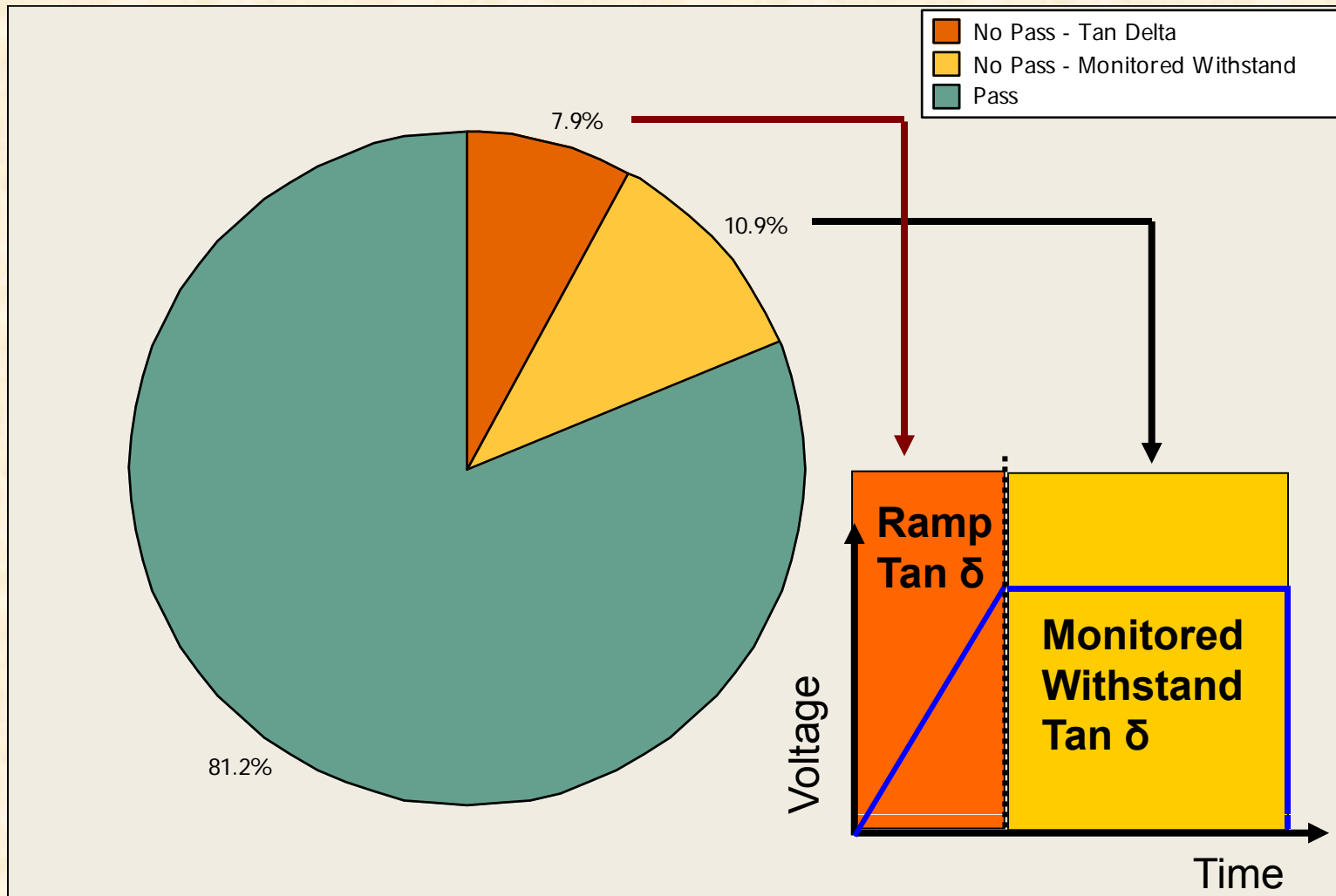
OR

High Dielectric Loss

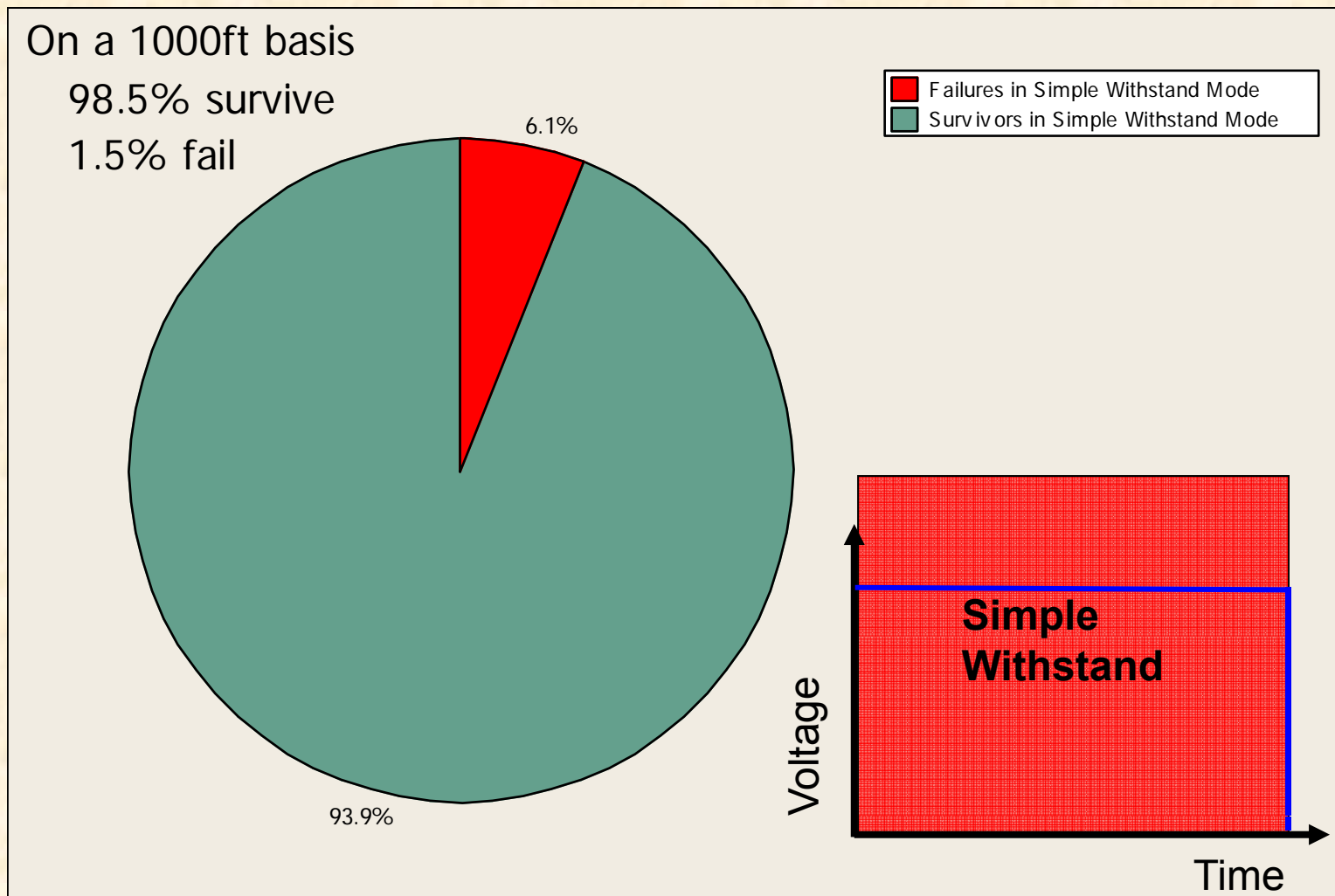
OR

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

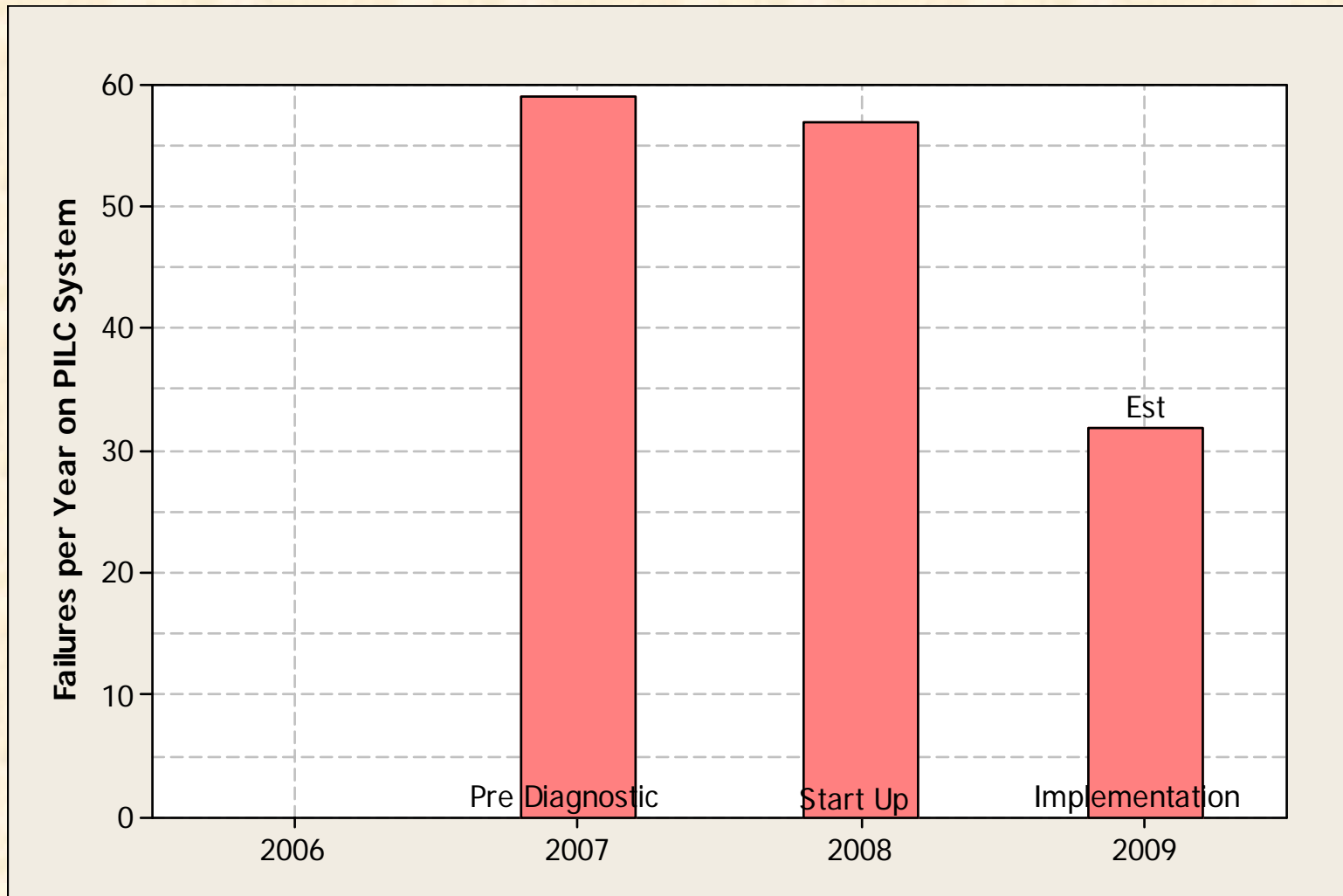
Monitored Withstand Results



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

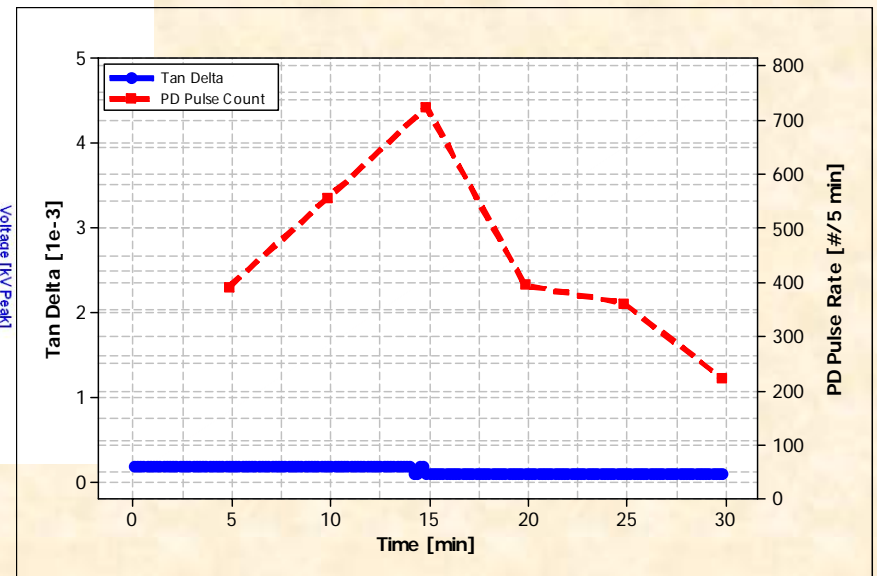
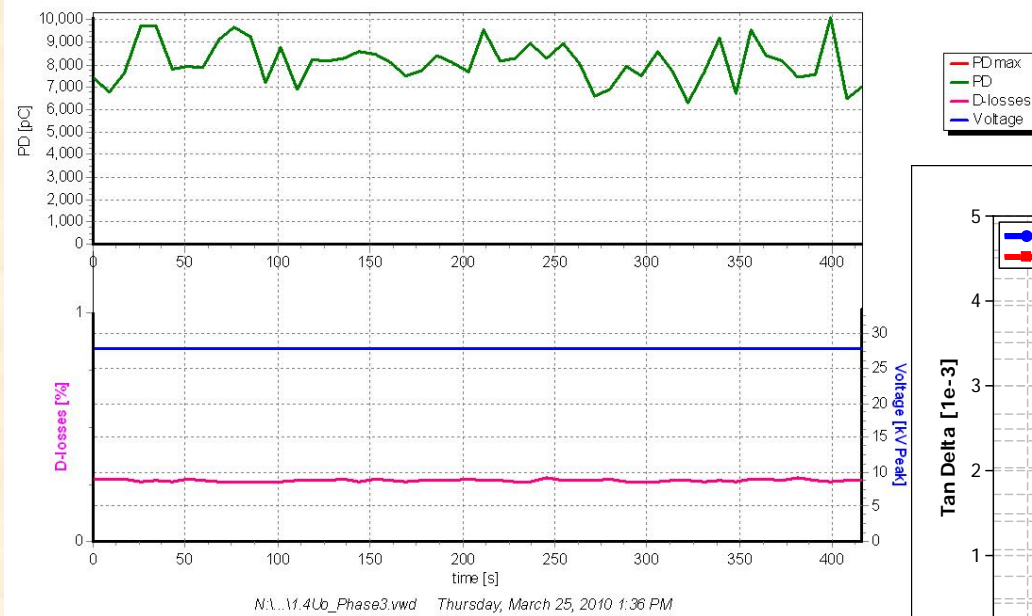
Combined Diagnostics - Monitoring

- DAC

- UWB PD
- Dielectric Loss

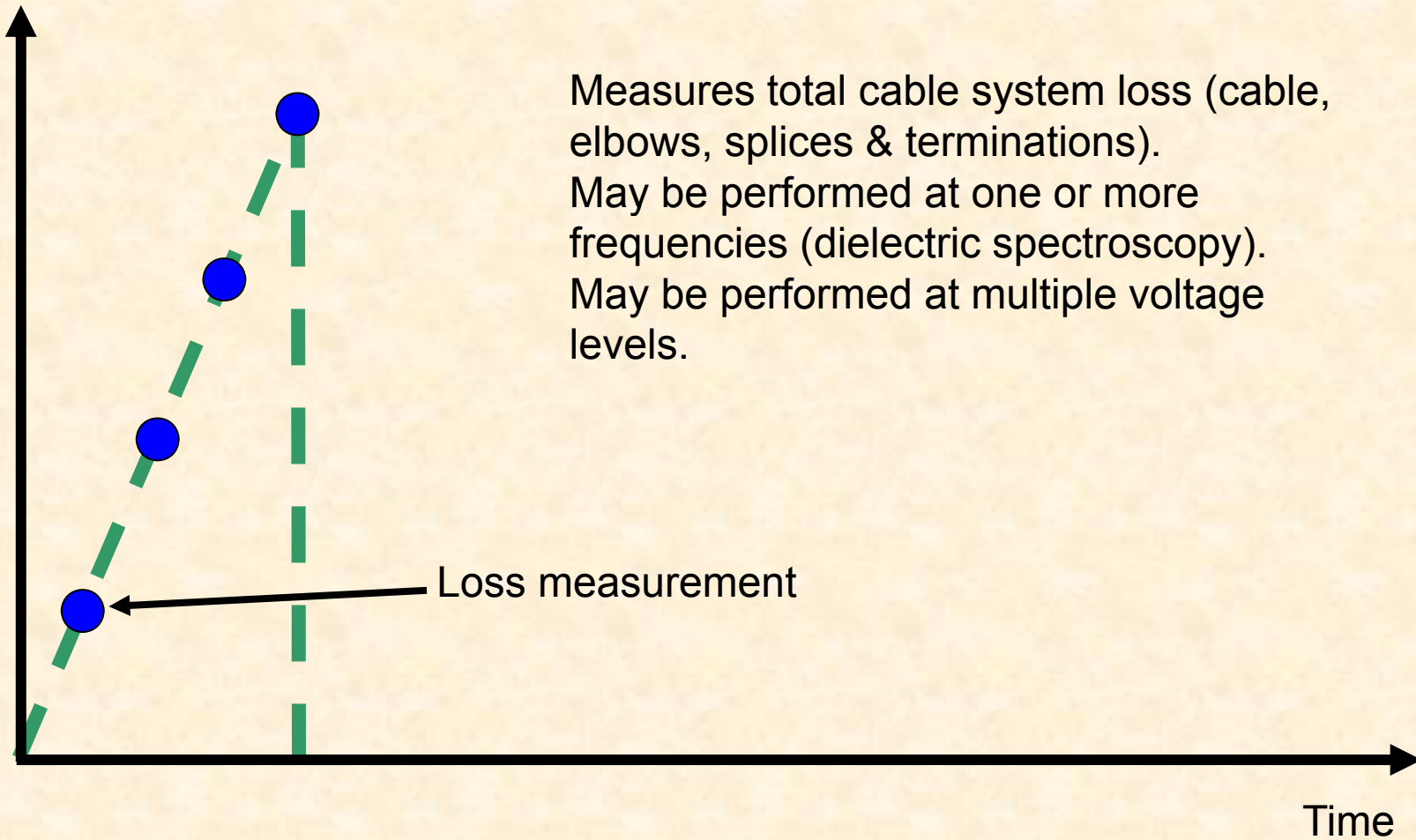
- VLF

- Tan Delta
- UWB PD

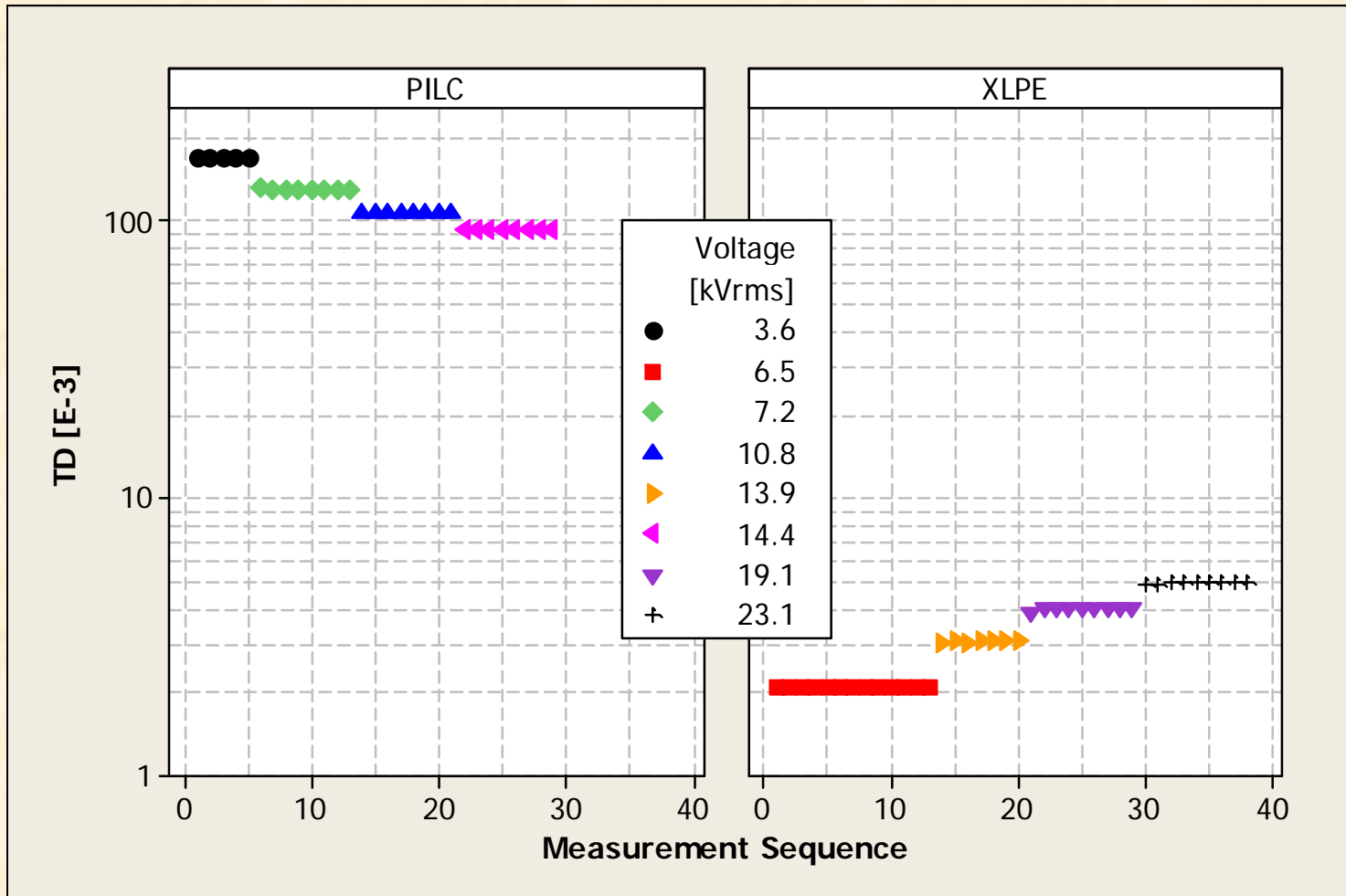


Dielectric Loss Test Process

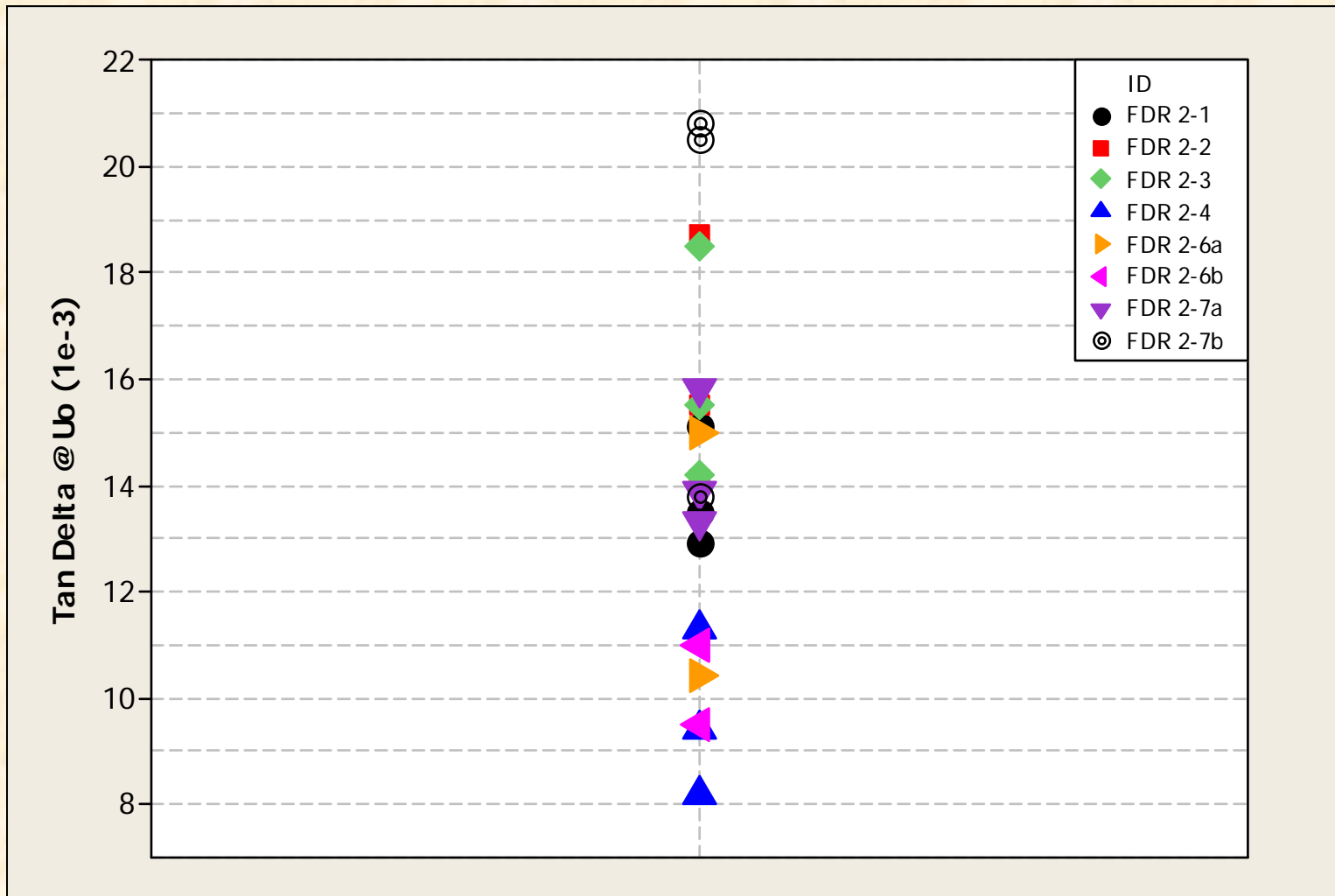
voltage



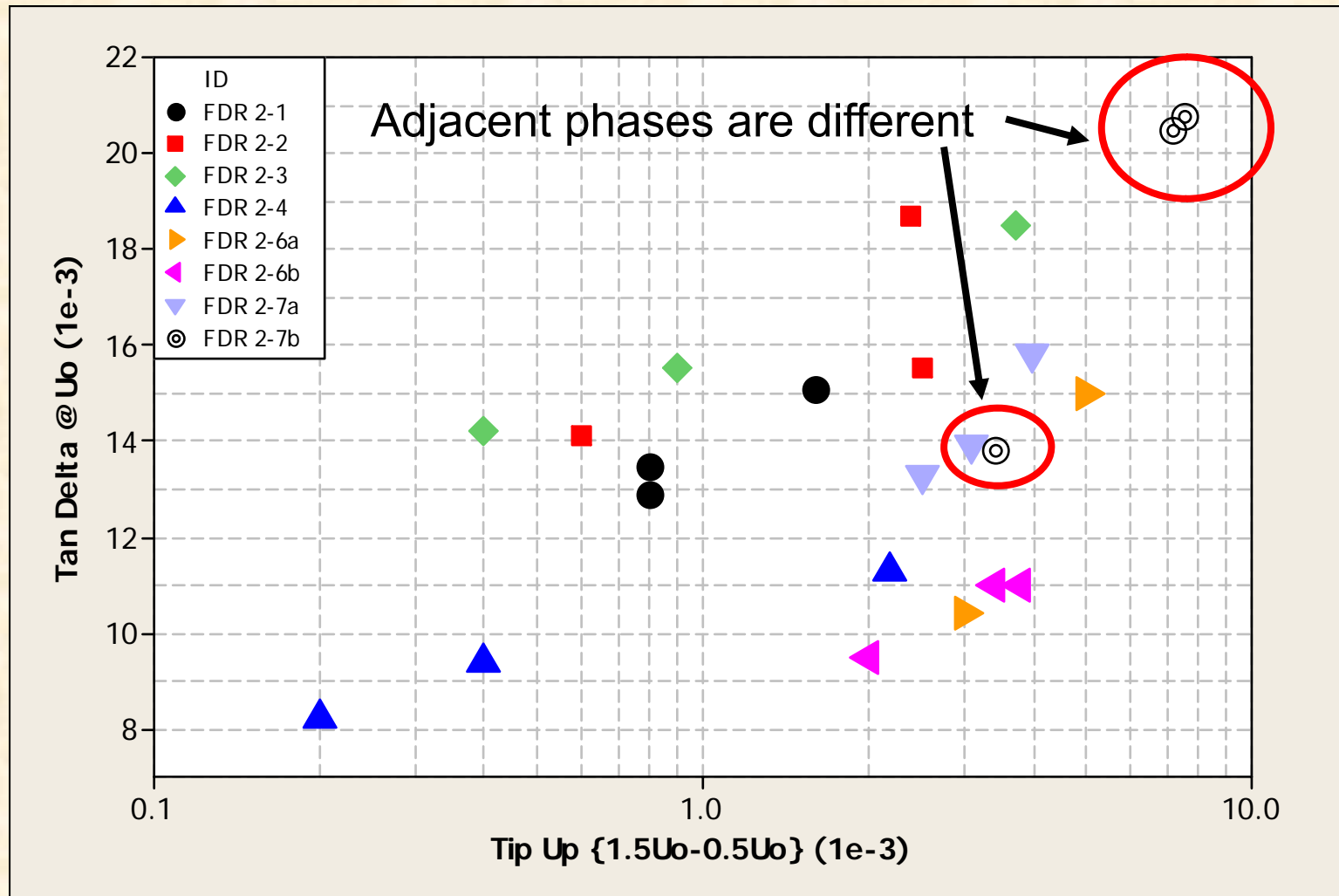
Measured Tan δ data from Cable Systems



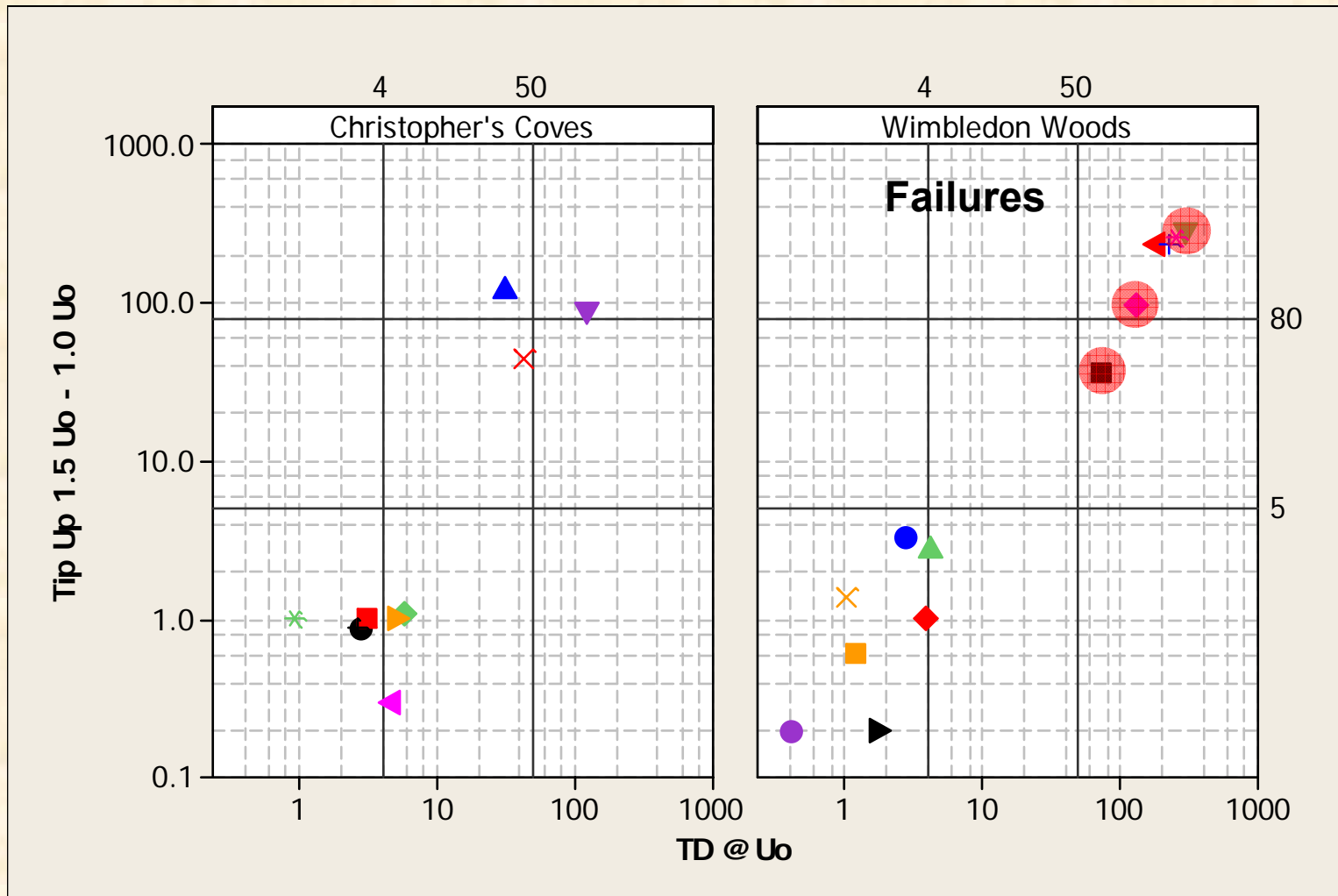
Tan δ at U_0



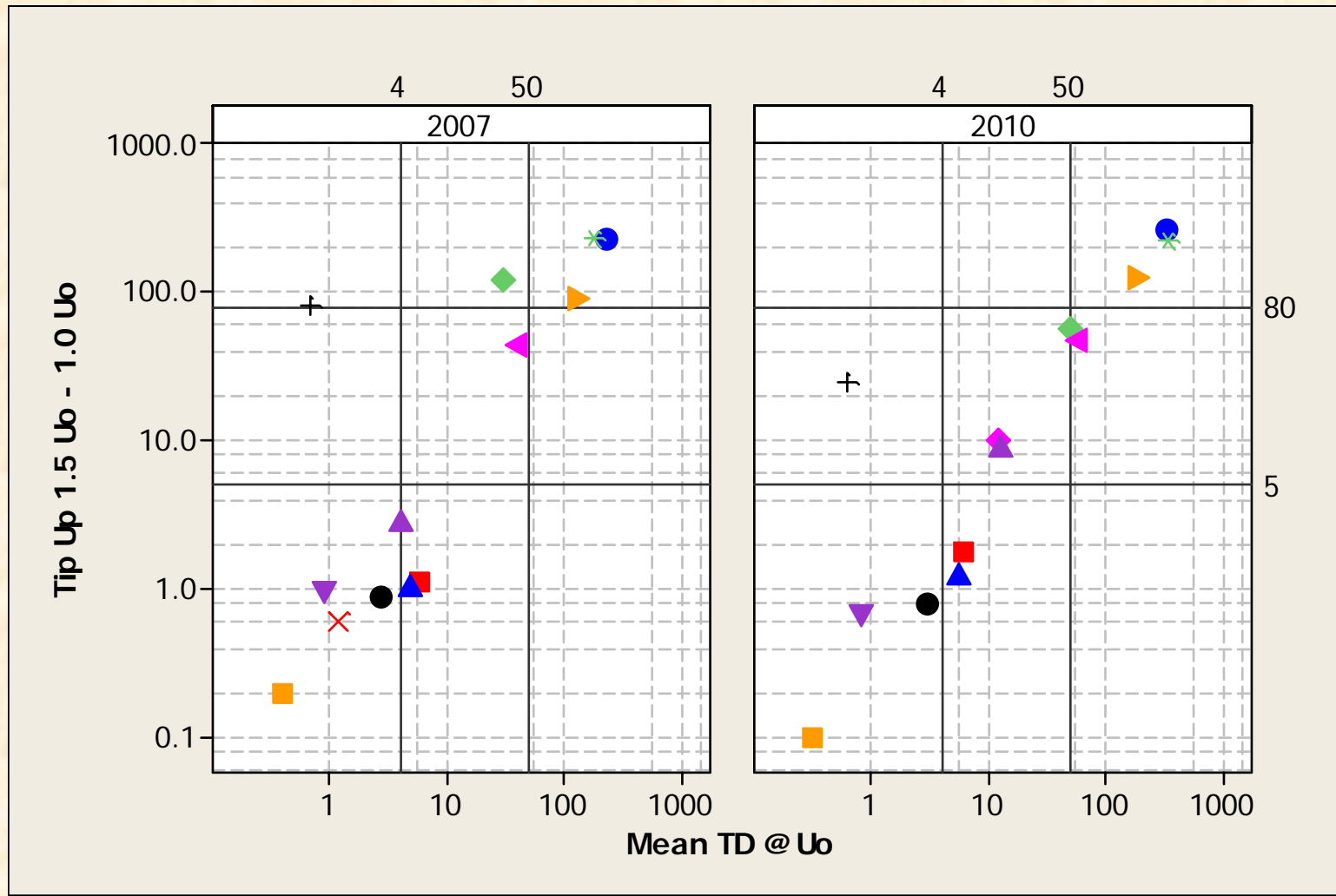
Tan δ and Tip Up Map



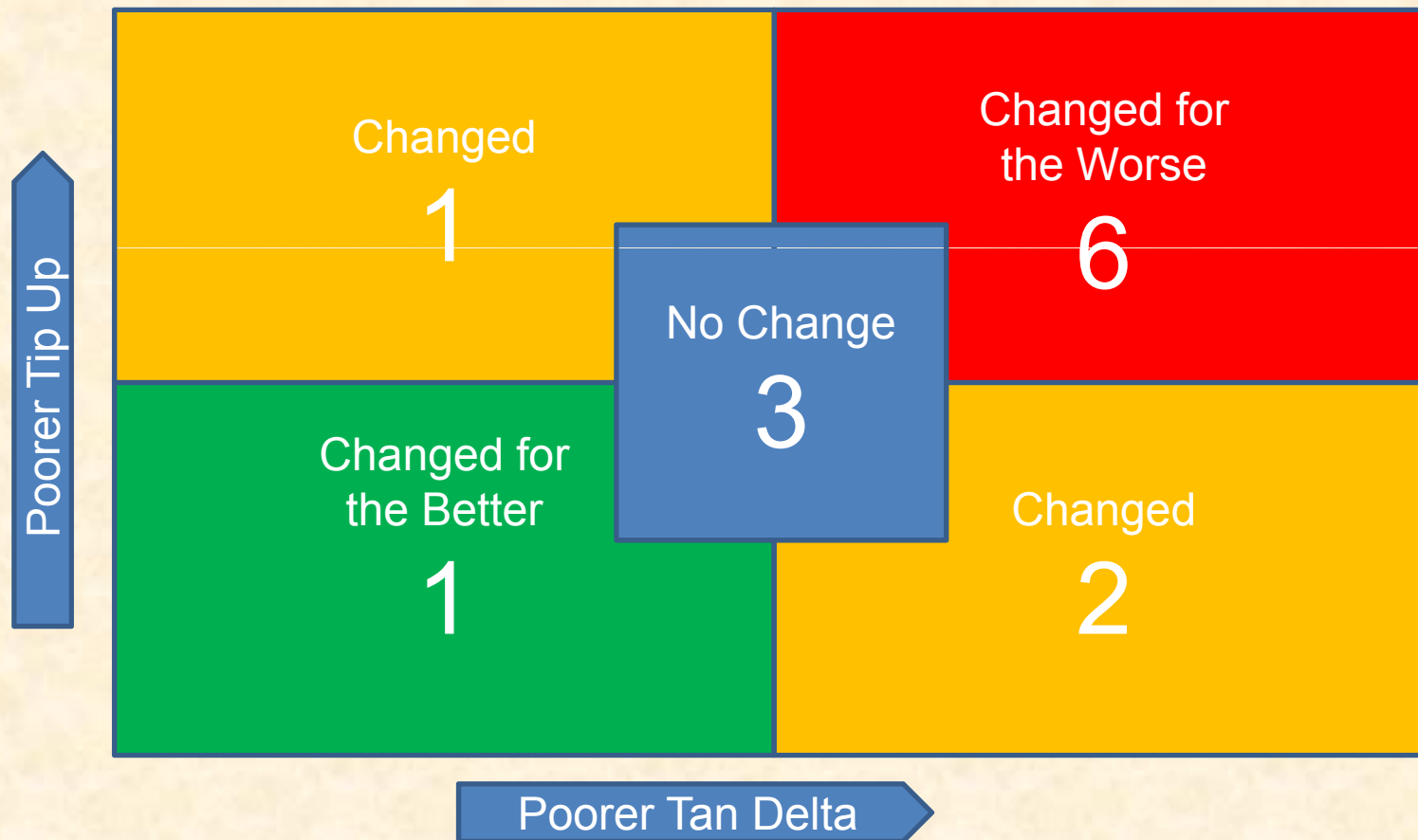
Jacketed & Unjacketed XLPE Data- 2007



2010 versus 2007 Results

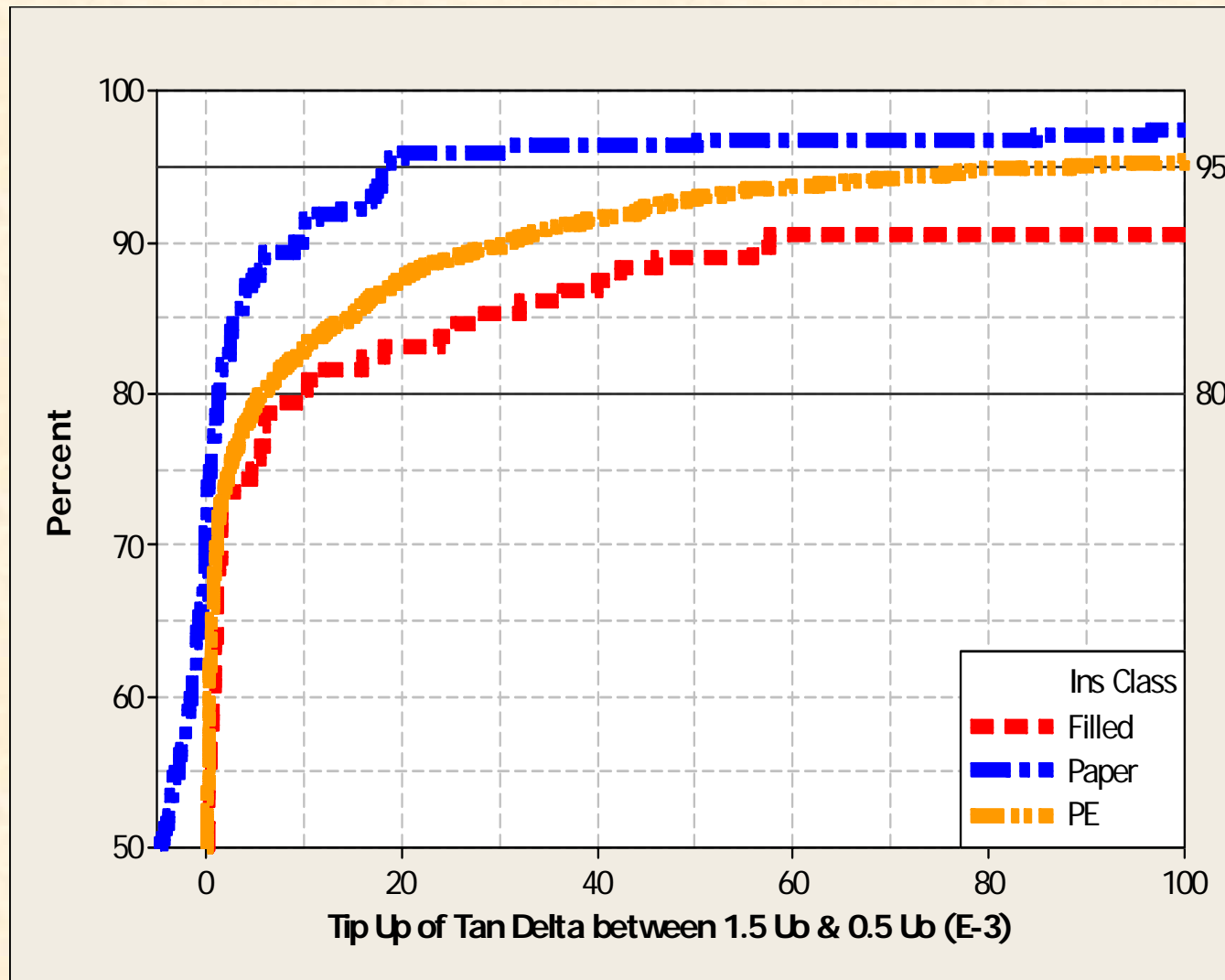


Jacketed & Unjacketed Data



Three "Action Required" failed before testing in 2010

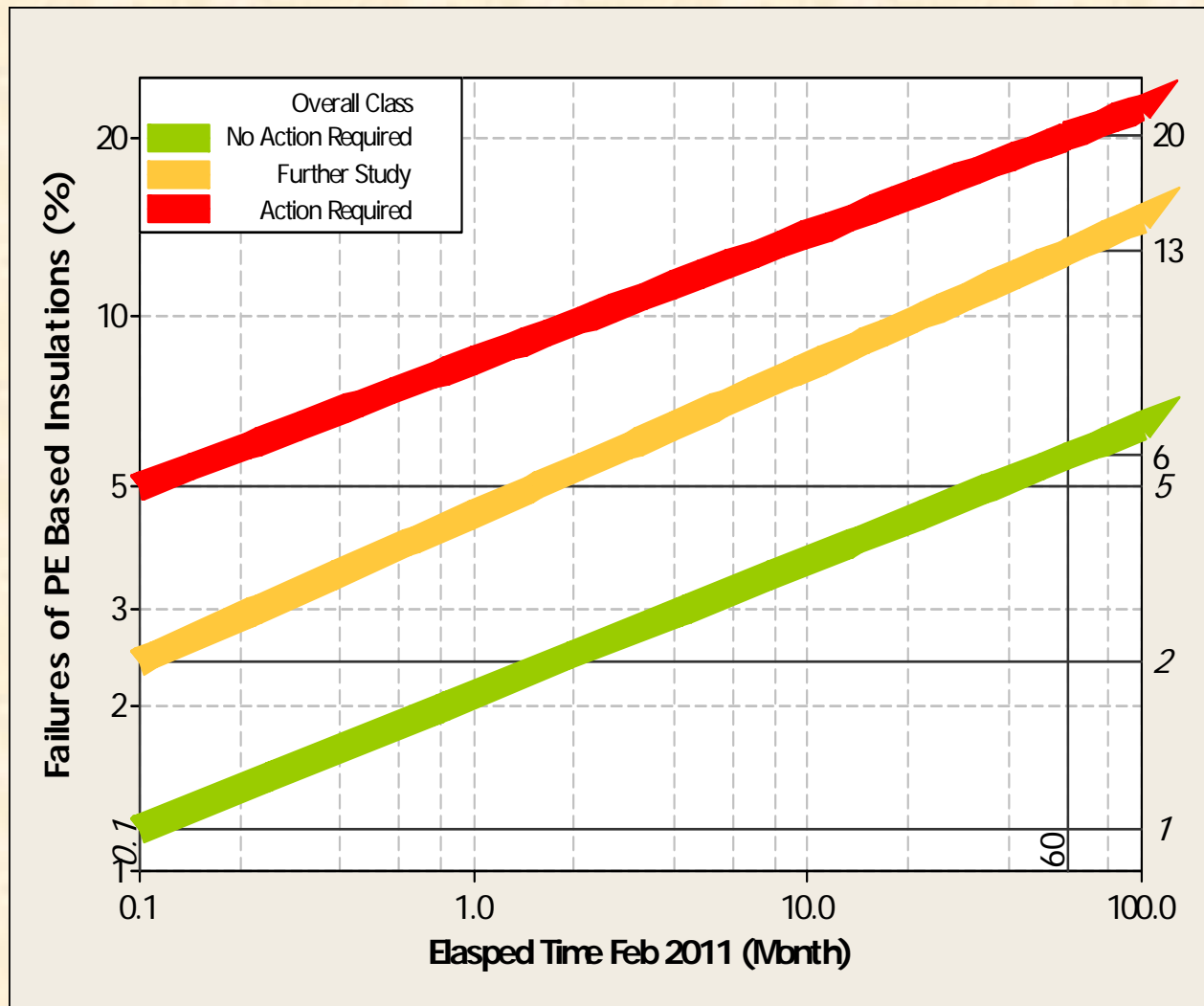
Criteria



Assumption of “unusualness” based on the 80th & 95th 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 δ will lead to failure.
6. Tan δ & PD measurements require interpretation to establish how to act.