

Underground Transmission Cable Monitoring – Lessons Learned at AEP

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CIGRE Grid of the Future
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Agenda

AEP Overview



Drivers for Monitoring

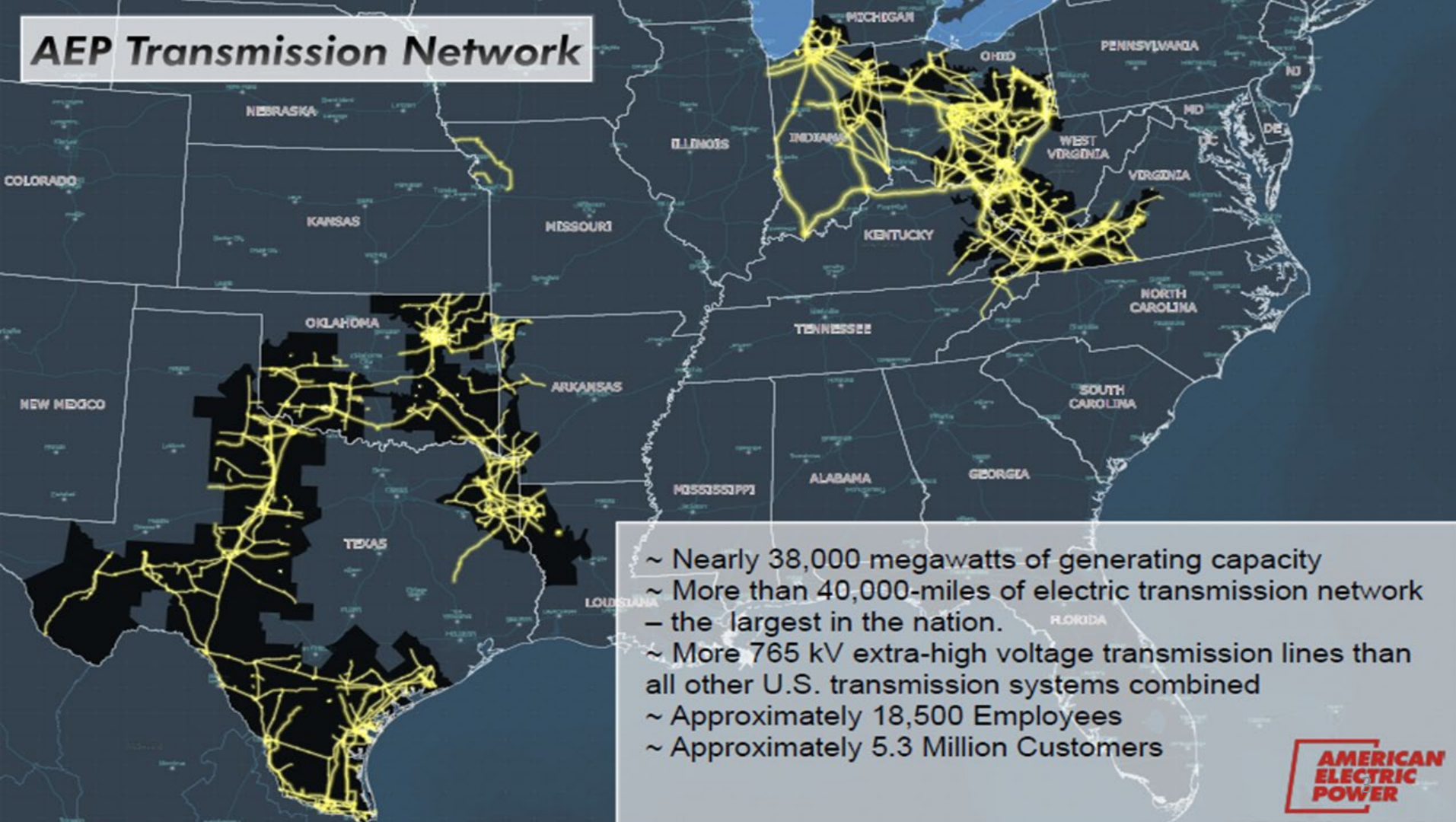


UG Cable Monitoring Pilots



Next Steps

AEP Transmission Network



- ~ Nearly 38,000 megawatts of generating capacity
- ~ More than 40,000-miles of electric transmission network – the largest in the nation.
- ~ More 765 kV extra-high voltage transmission lines than all other U.S. transmission systems combined
- ~ Approximately 18,500 Employees
- ~ Approximately 5.3 Million Customers

AEP UG Cable Statistics



UG T-Cable Mileage – 100 miles

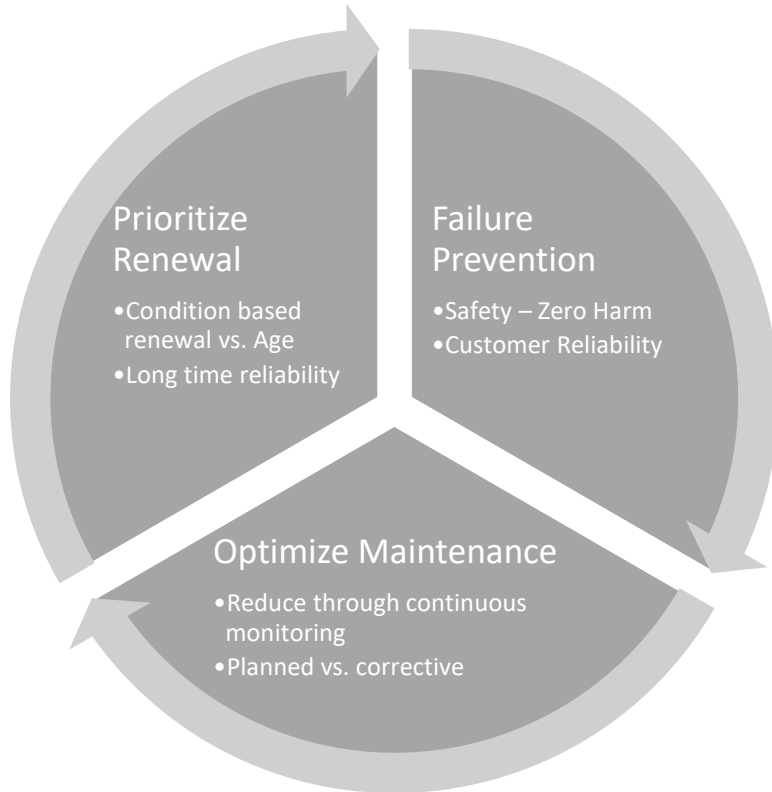
- XLPE, HPFF, HPGF
- 34kV – 138kV



T-Line Mileage – 40,000 miles

- Up to 765kV

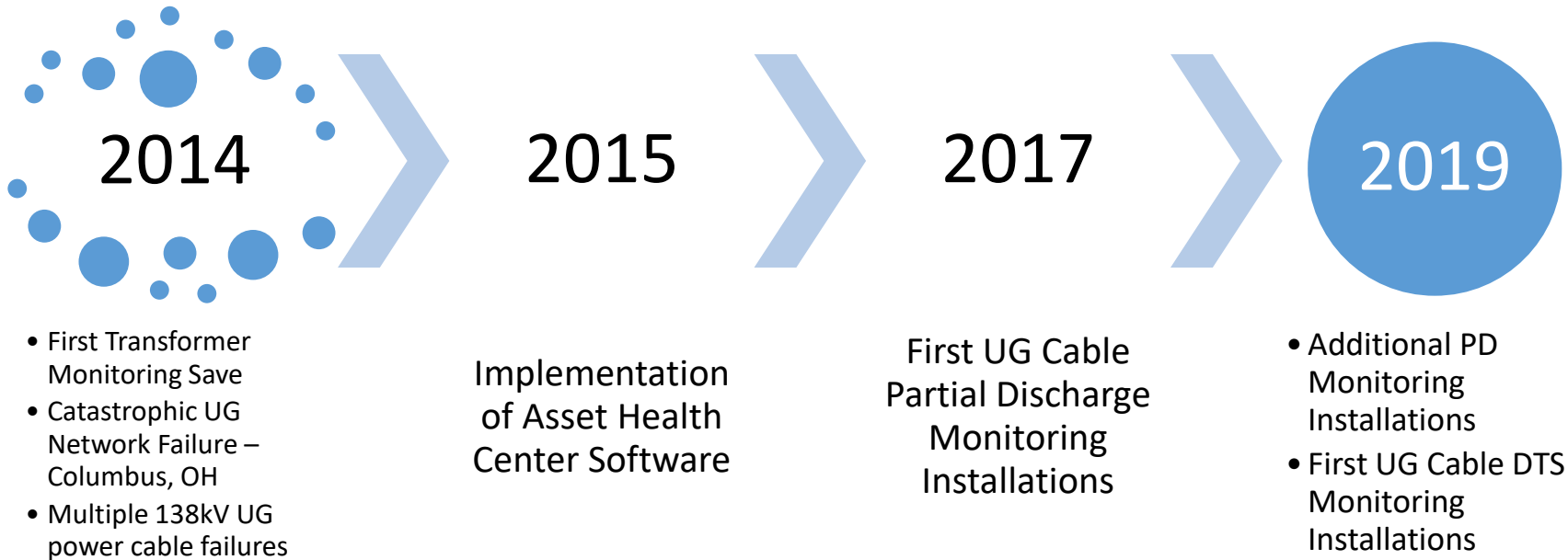
Asset Health Center Goals



Current Benefits Achieved

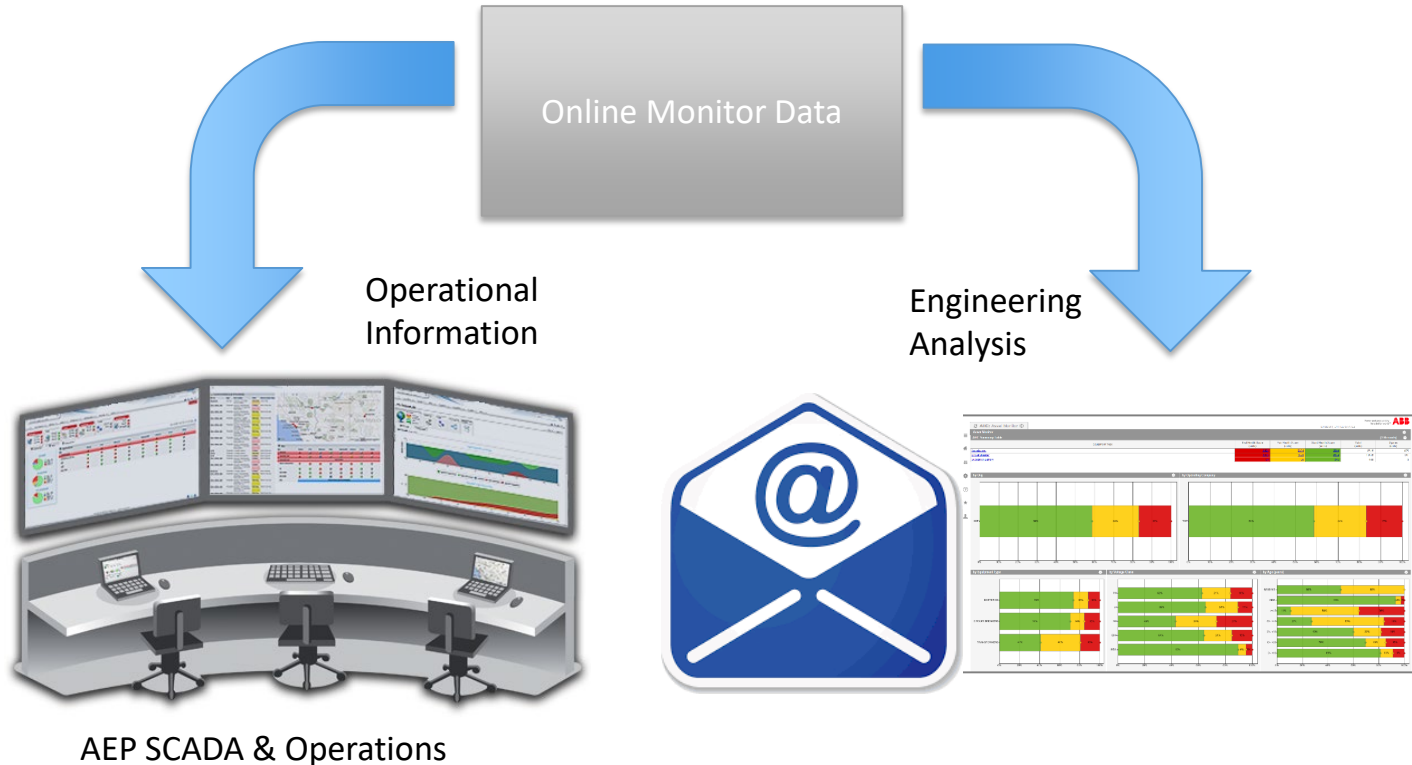
- Failure Prevention
 - 13 EHV Transformer Failures Prevented
 - **\$50M** in maximum potential savings
 - Remote monitoring reduces travel to stations
- Maintenance Optimization
 - Reduction in maintenance activities
 - Cooling and wiring issues discovered via monitoring
 - Reducing alarms to operations
- Prioritize Renewal
 - Online monitor data used in algorithms for condition based, data driven decisions
 - Decision making process improvements due to condition based monitoring equipment

Asset Health Timeline





AEP's Data Driven Communications Solution

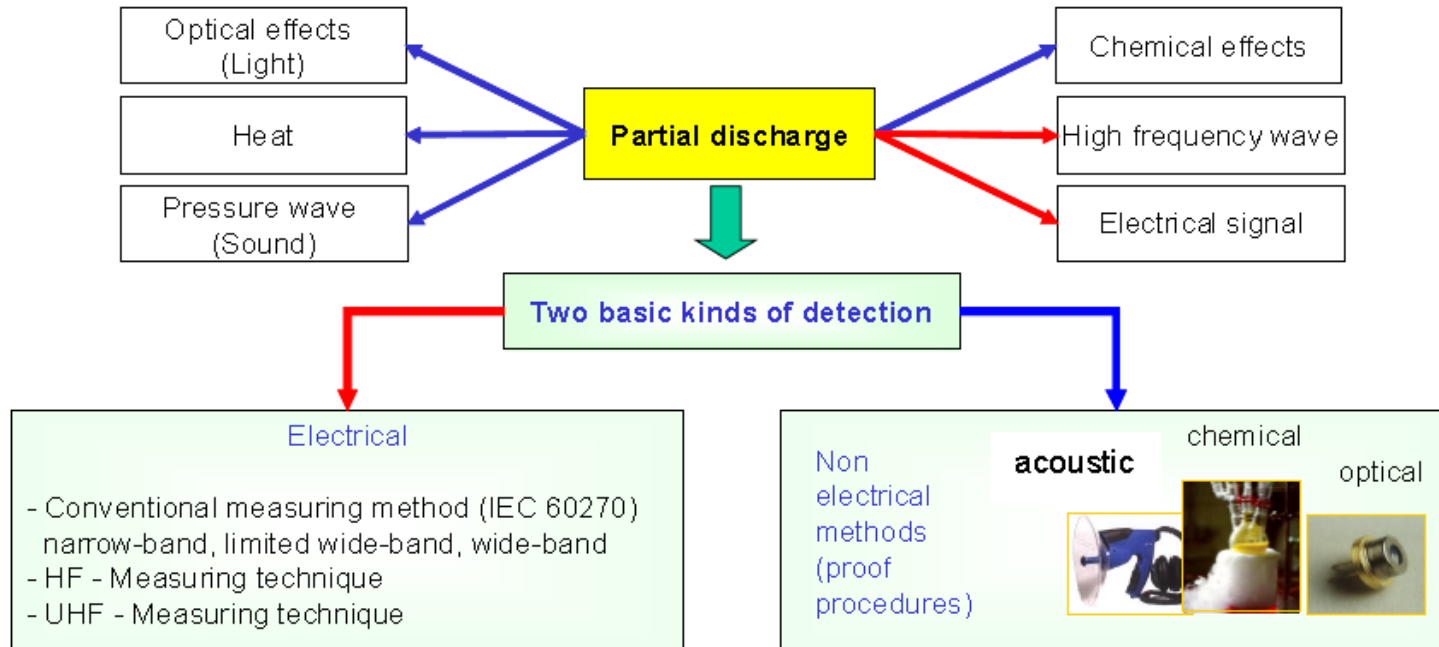


Overview and Experiences

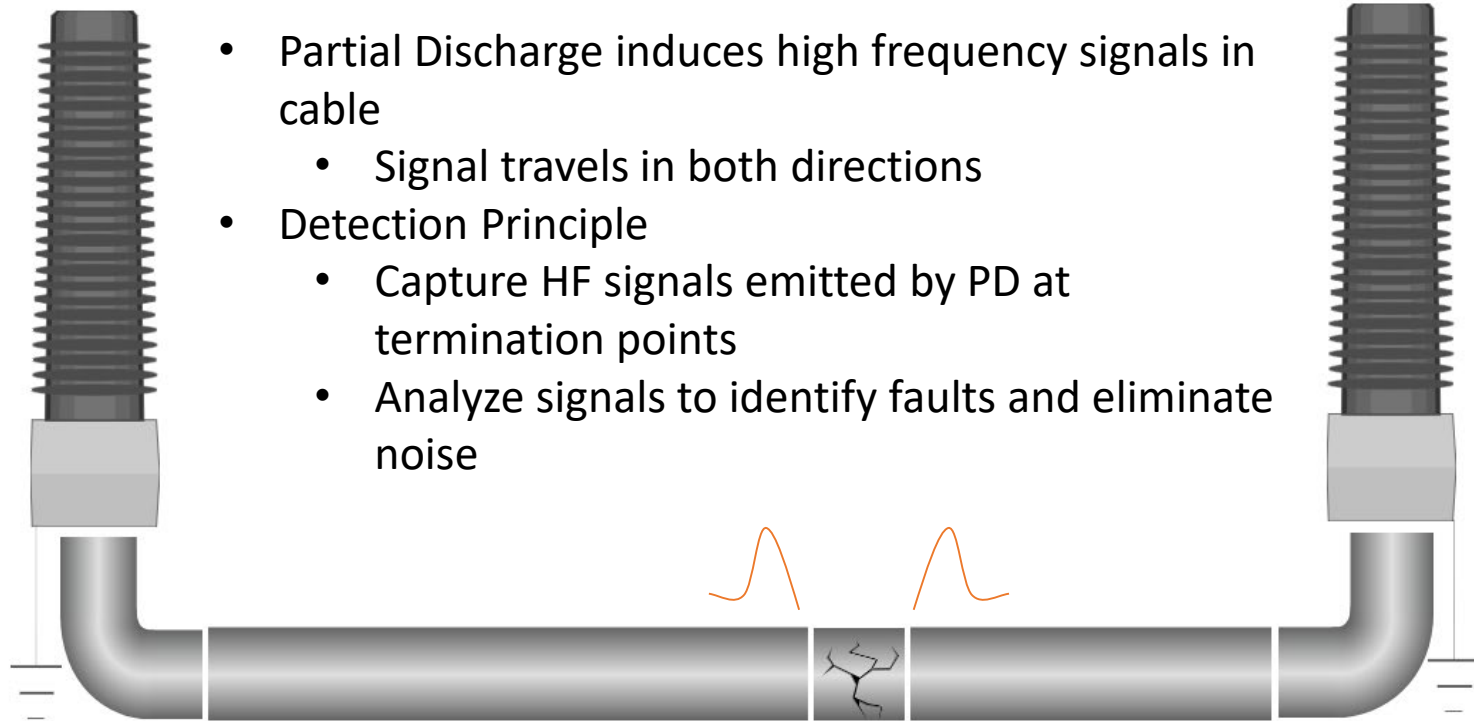
UG CABLE PARTIAL DISCHARGE MONITORING

What is Partial Discharge?

Physical effects of partial discharge

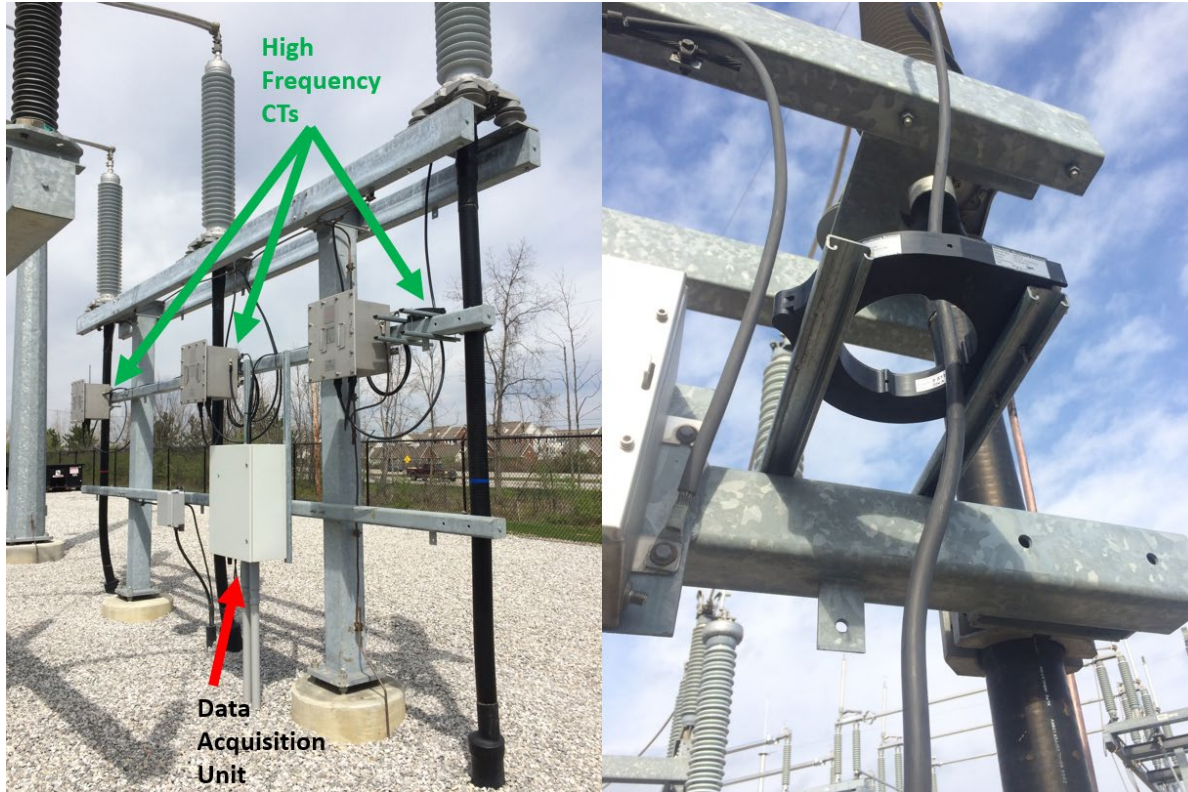


Partial Discharge Measurement



- Partial Discharge induces high frequency signals in cable
 - Signal travels in both directions
- Detection Principle
 - Capture HF signals emitted by PD at termination points
 - Analyze signals to identify faults and eliminate noise

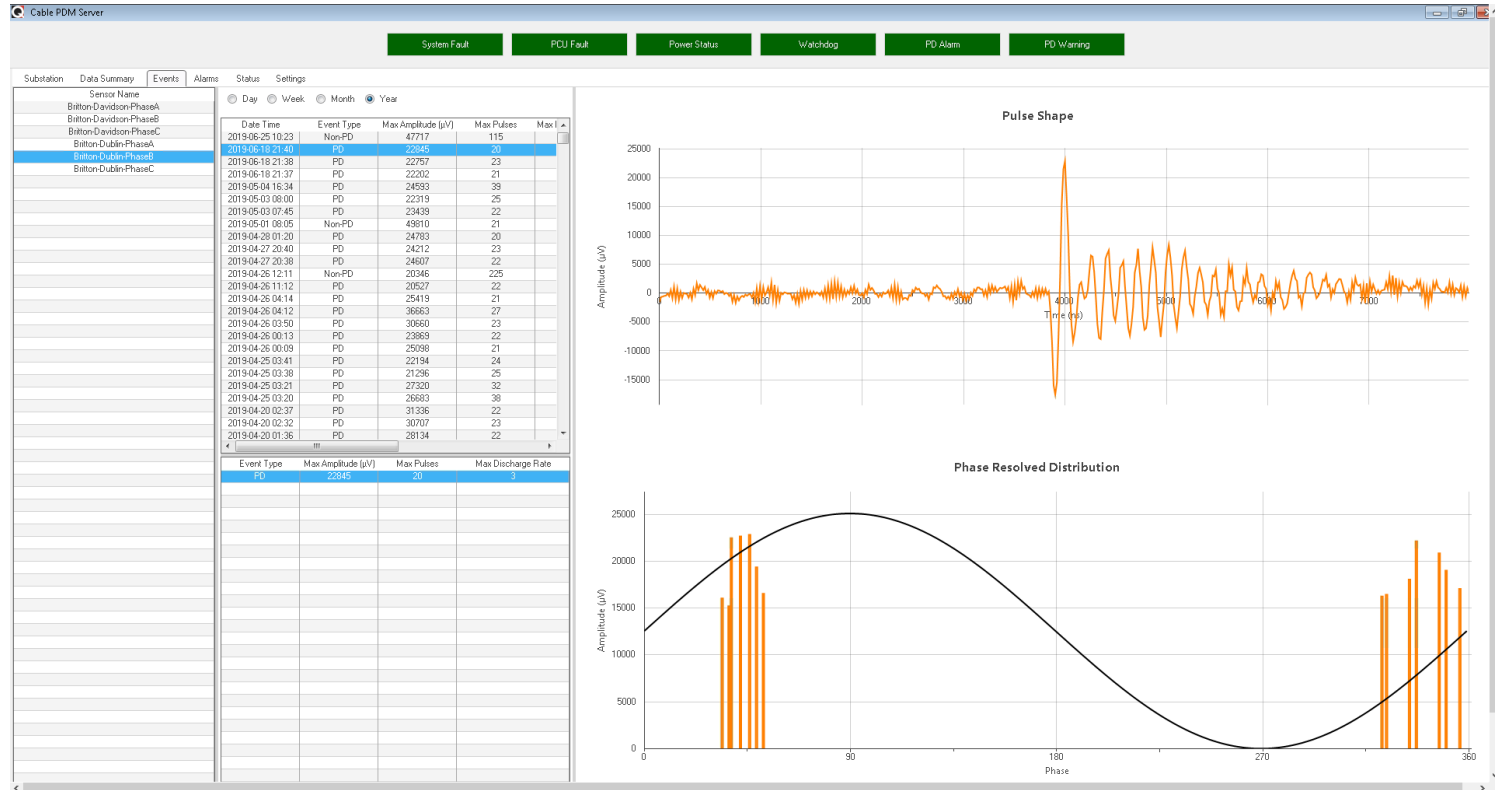
Installation Diagram



Cable PD Monitoring Systems

- 138kV Circuits Fully Monitored: 1
 - Circuit 1 – 0.53 miles
- 138kV Circuits Partially Monitored: 3
 - Circuit 2 – 2.63 miles
 - Circuit 3 – 1.13 miles
 - Circuit 4 – 4.42 miles
- First Installation: 2016
- Latest Installation: 2019

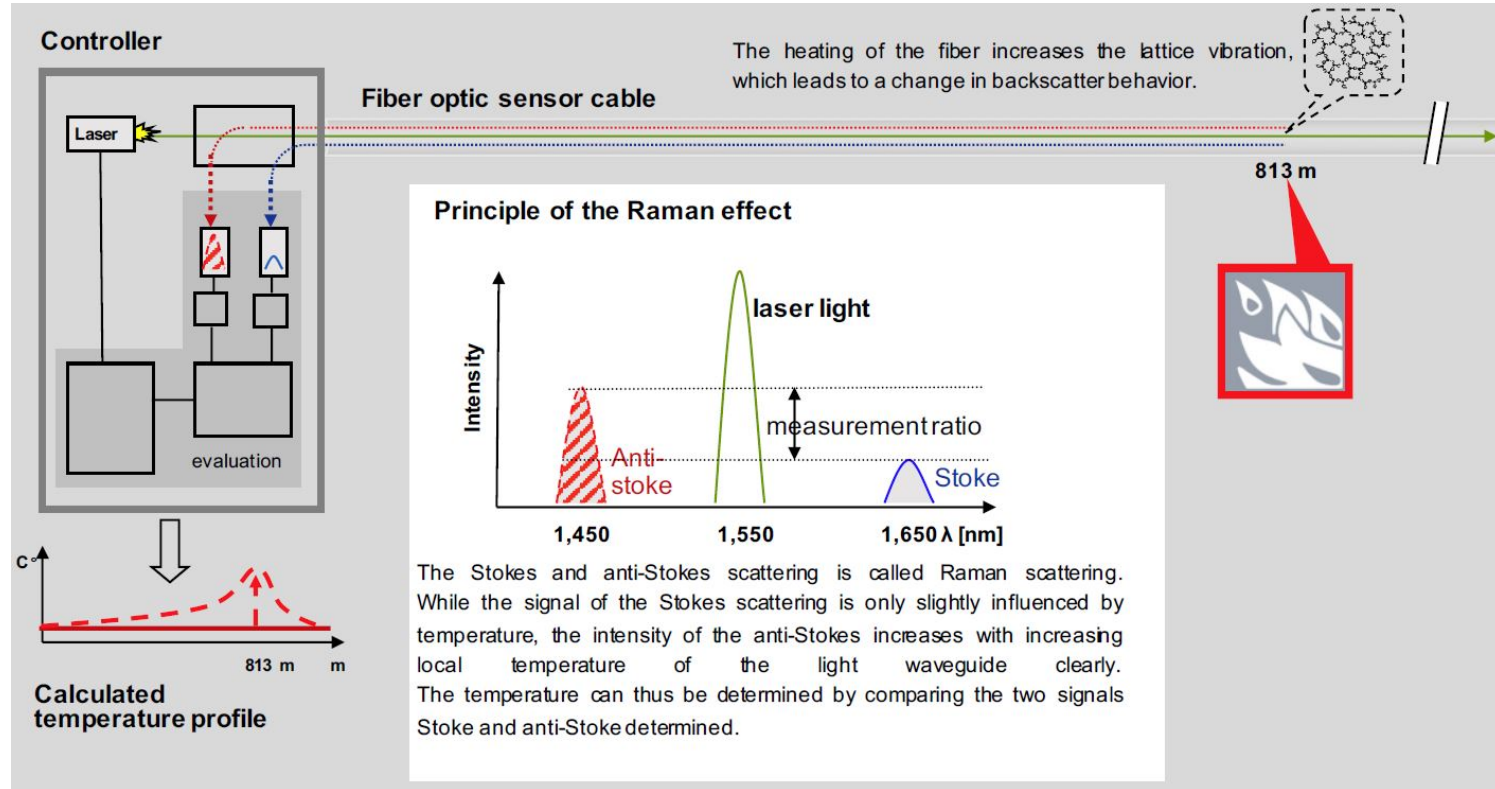
Partial Discharge Analysis



Overview and Experiences

UG CABLE DISTRIBUTED TEMPERATURE SENSING

What is DTS?

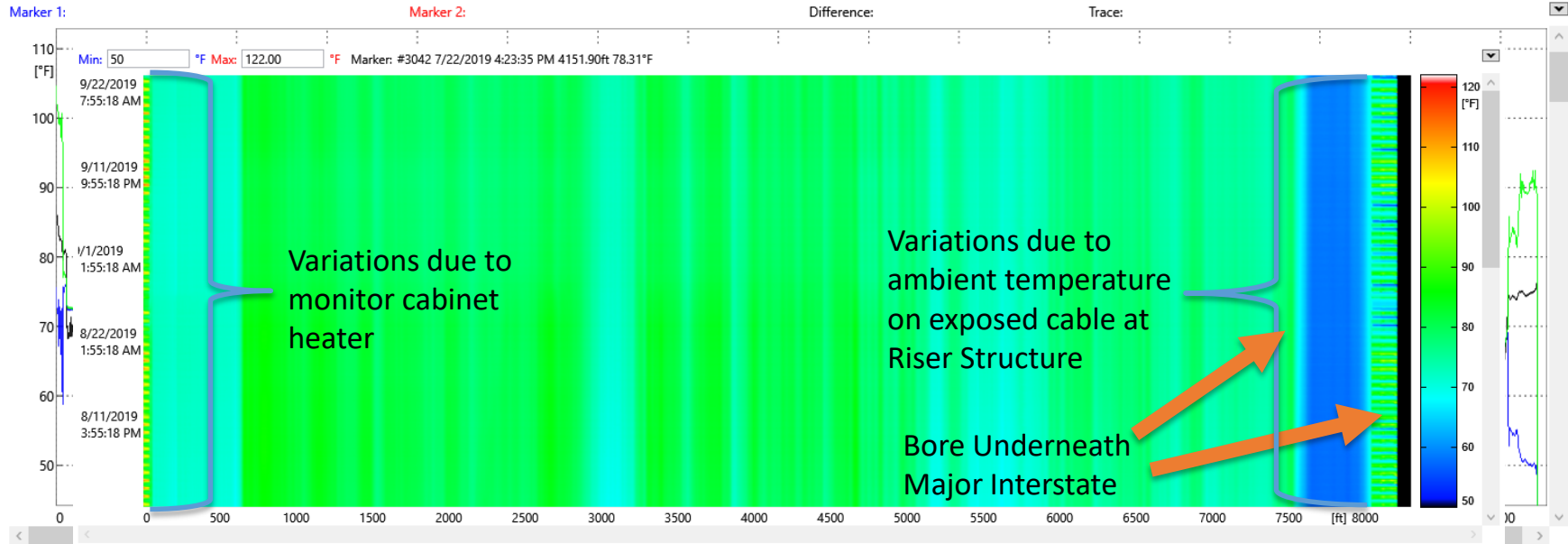


Pilot Installation #1

- 40kV Circuit – 69kV design
 - Circuit 5 – 1.34 miles
- System Commissioned and Operational by Vendor#1
- Working/learning about the Real Time Thermal Rating software
- No alarms to transmission operations
 - Email alerts only



Pilot Installation #1 Monitor Data



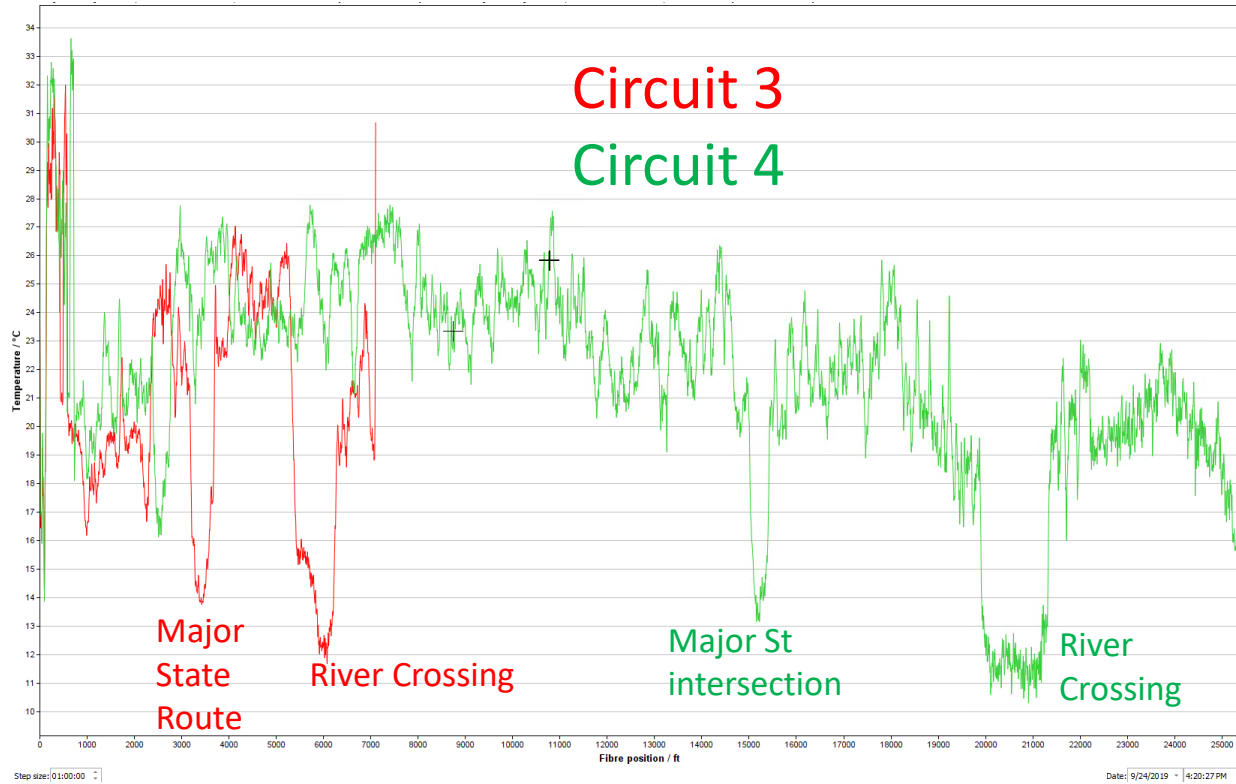
Pilot Installation #2

- Two 138kV UG Cable Circuits
 - Circuit 3 – 1.13 miles
 - Circuit 4 – 4.42 miles
- System Commissioned and Operational by Vendor 2 in June 2019
- Working/learning about the Real Time Thermal Rating software
- No alarms to transmission operations
 - Email alerts only





Pilot Installation #2 Monitor Data

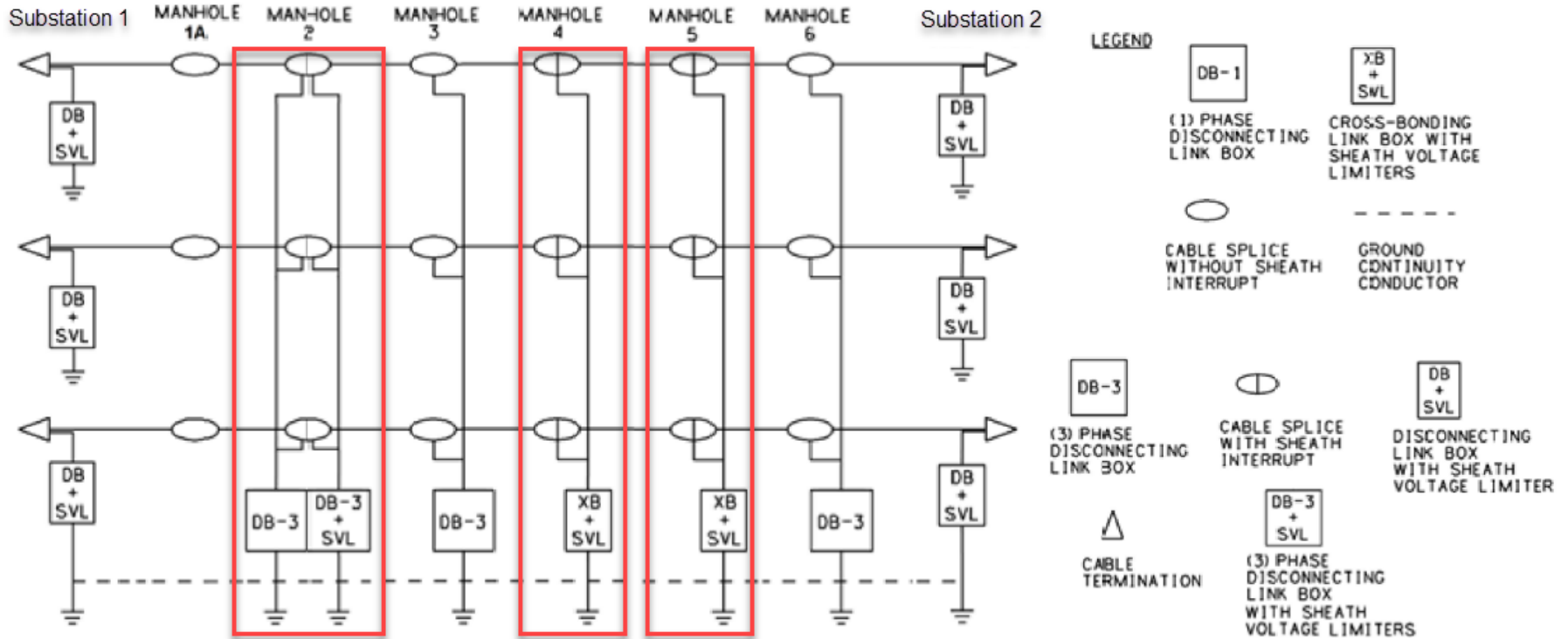


LESSONS LEARNED & NEXT STEPS

2018 Cable Failure – Circuit #2



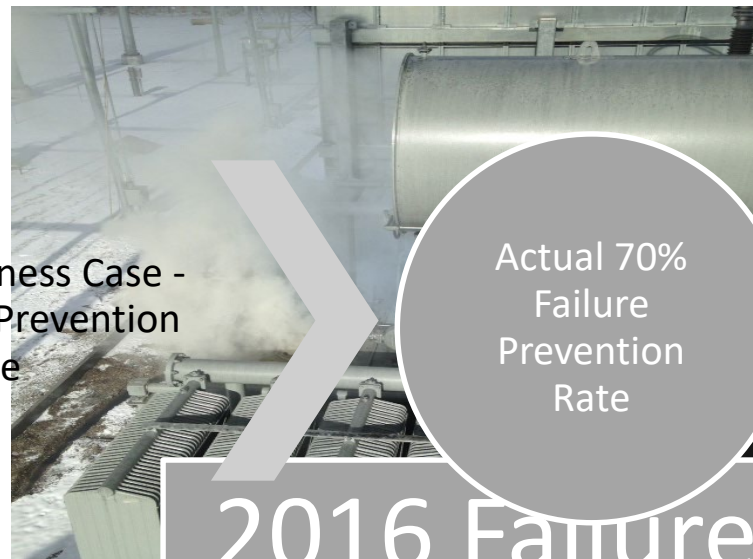
Cable PD Monitoring - Grounding



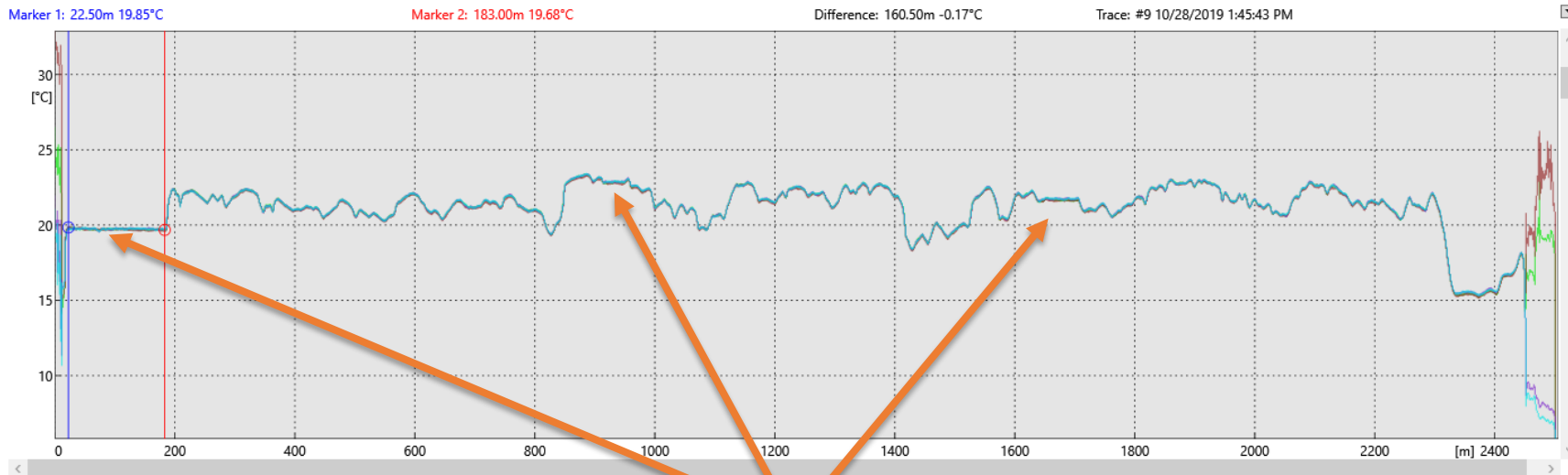
2018 Cable Failure – Continuing to Learn



Original Business Case - 50% Failure Prevention Rate



DTS Fiber Documentation



Fiber Maintenance Loop Locations

Next Steps

Pilot Installations

- 2019 PD / DTS Installation
- 2020 DTS Installations

Data Analysis and Visualization

- Incorporate monitor data into Asset Health Center algorithms

Technology Evaluation

- Continue evaluating PD monitoring
- Evaluate DTS vendors
- Evaluate possible UG Cable Standard

Other Technology Deployments

- Can DTS be utilized for other AEP Transmission Assets?
 - Transformers
 - T-Lines
 - Substation Batteries

Thank you!

QUESTIONS?