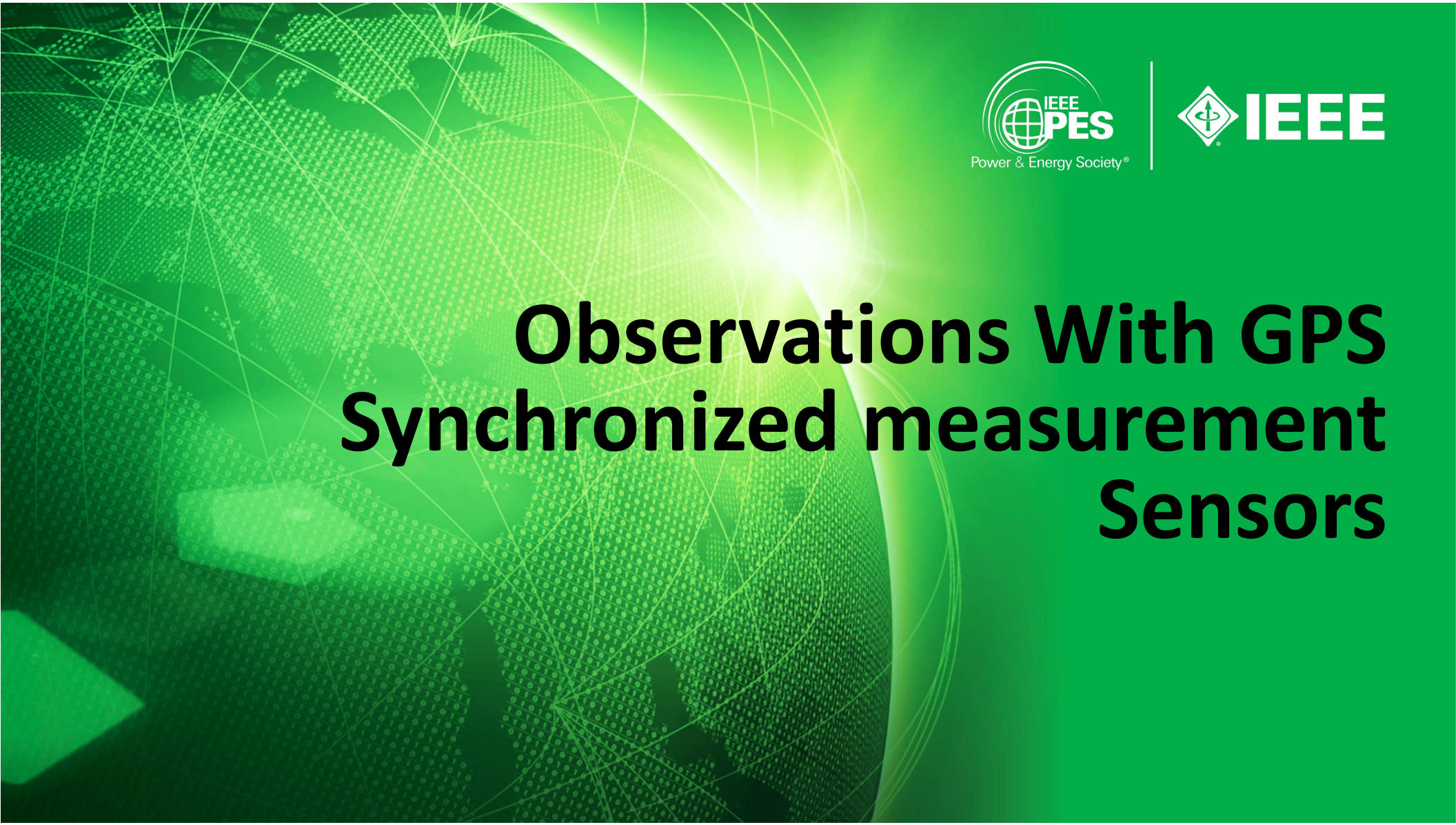
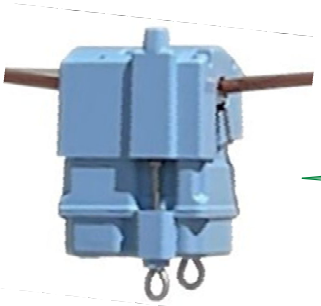
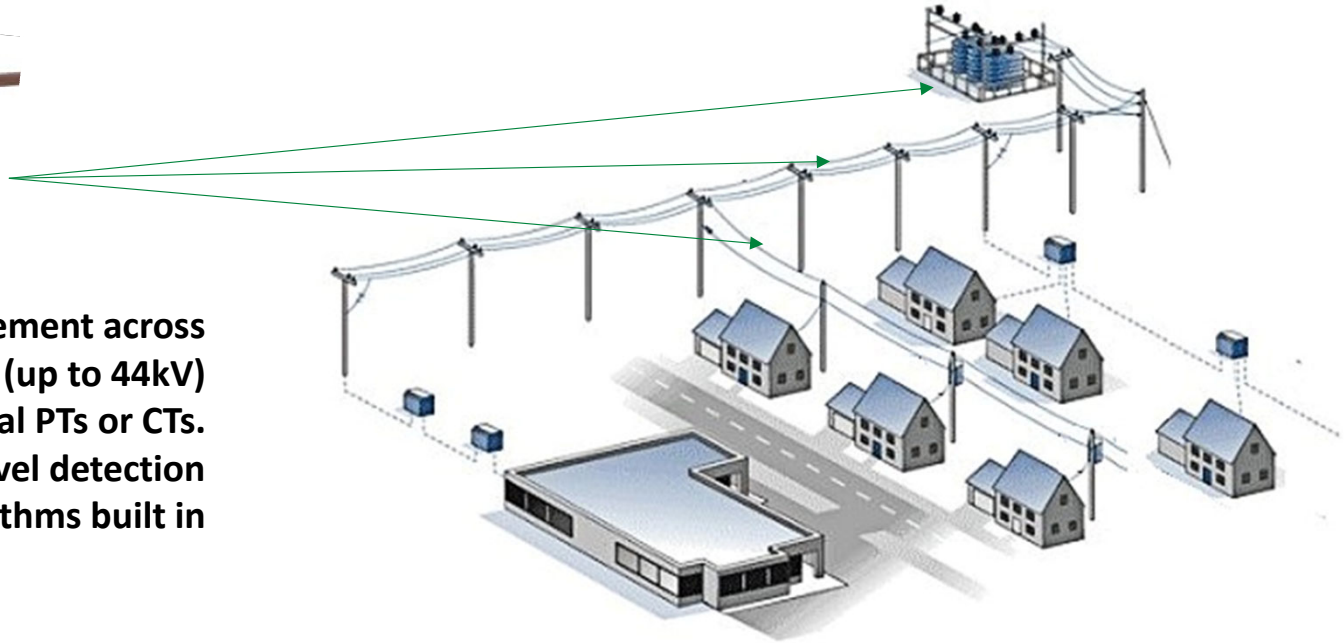


Observations With GPS Synchronized measurement Sensors

Sentient Sensor

Overhead Line Sensor





GPS Synchronized measurement across the distribution system (up to 44kV) without the need for additional PTs or CTs. With advanced disturbance level detection algorithms built in

Sentient Sensor

Sensor capabilities

- Constant monitoring and exception-based synchcro-waveform capturing
- 132 samples/cycle sampling rate
  - (supports up to 21st harmonic capture)
- High resolution measurement (amplitude, frequency)
- Captures E-field, amperage, temperature
- Captures and reports fault data
- Can capture and report disturbance data
  - When activated, captures pre- and post- disturbance data (10 cycles either side)
  - Information fed into Sentient's cloud analytics platform to drive actionable insights

Observation 1

Things look different depending on the point of observation.

Things look different depending on the point of observation.

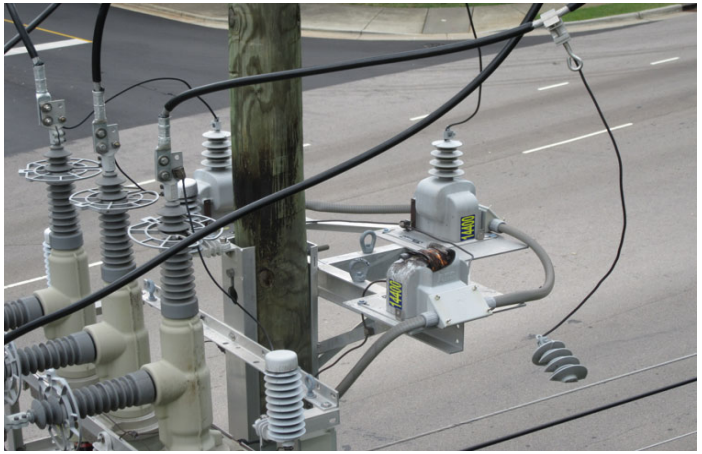
- Many factors between the phenomenon being observed and the observation device can lead to some tricky and interesting situations.

- What you are looking for also plays a role. Anomalies that indicated degradation and potential future failure do not always present at high magnitude and thus are harder to see when the sensor is farther away from the location where it occurs.

The Easy Stuff to See

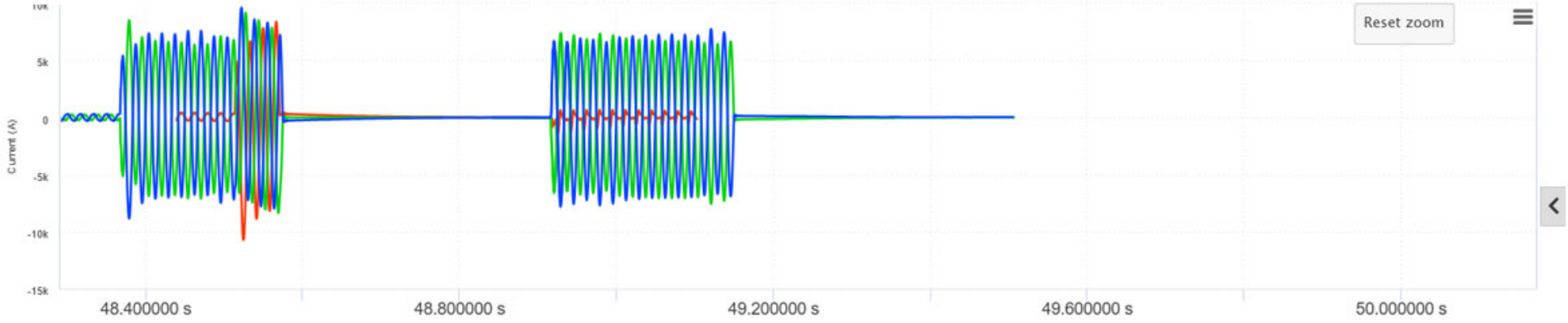
- A Bolted Fault presents a strong signature on the system that is easily picked up by relays or other devices and can easily be used to determine possible locations.

- These are the easy traditional textbook examples that people think about when envisioning outages on the electrical grid.

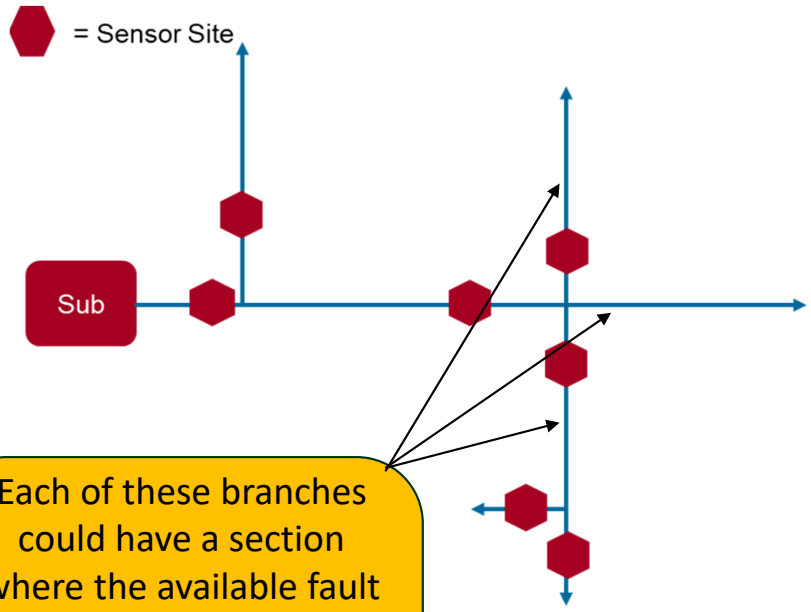


The Easy Stuff to See

- Multi Cycle Duration – Easily Calculated RMS short circuit value and traditional fault location methods can be used…

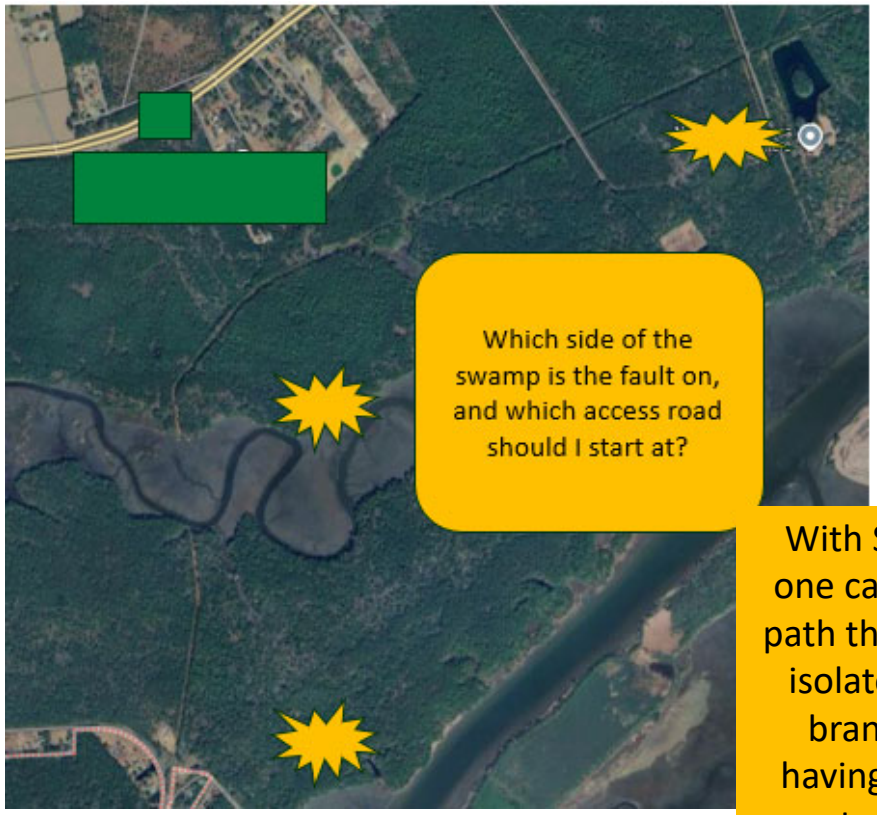


…but traditional fault location may give multiple possible locations



Each of these branches could have a section where the available fault current is similar to one another

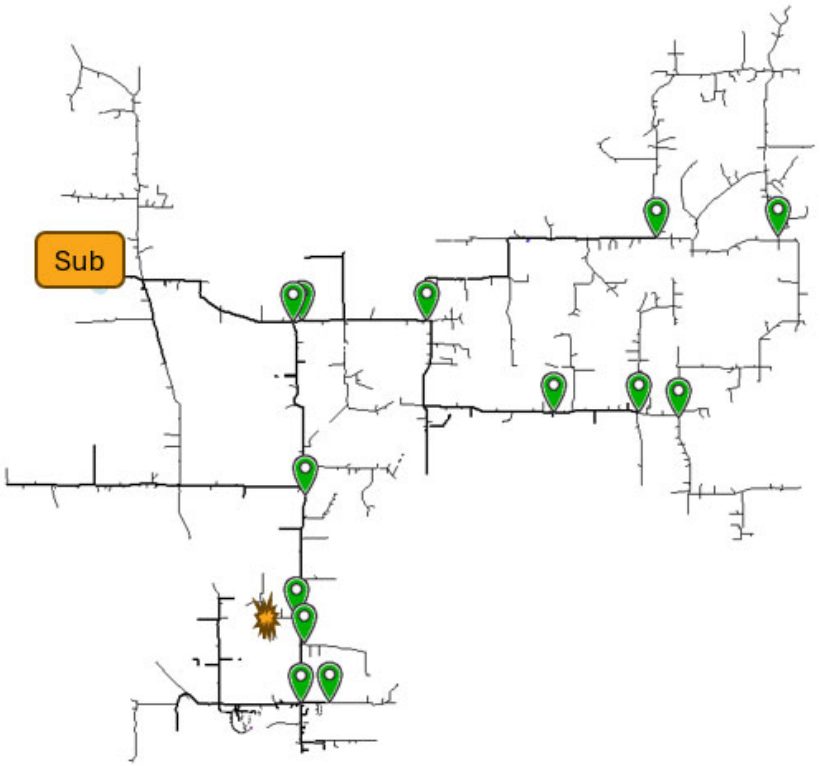
How is this countered?
SENSOR DENSITY



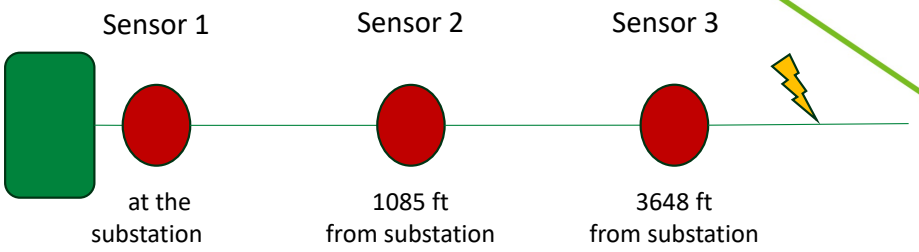
With Sensor Density one can easily tell the path the fault took and isolate down to one branch instead of having to waste time patrolling all three

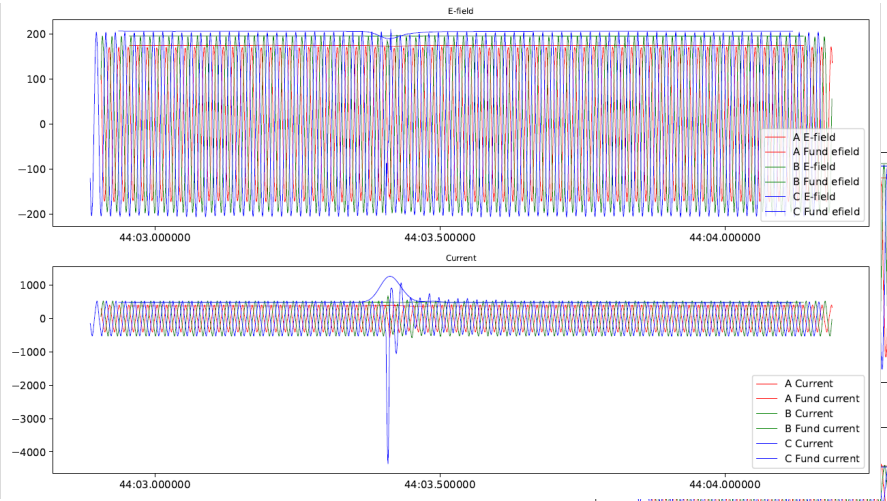
A Medium Level Challenge

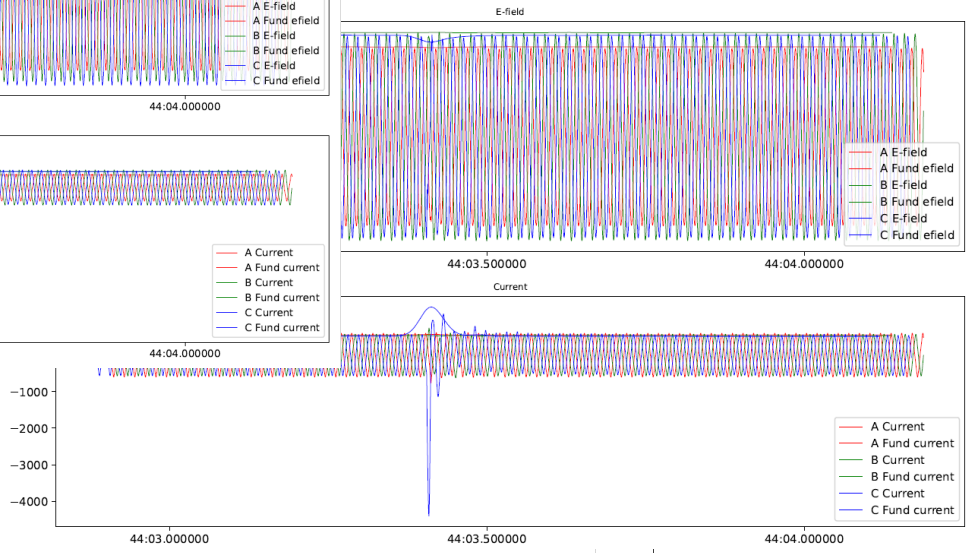
- Fault level events that are less than 2 cycles tend to present a bit more of a challenge from a location determination standpoint but can still be easily picked up.
- A high concentration of measurement devices can help with segmentation of such events to narrow the zone in which the event may have occurred.

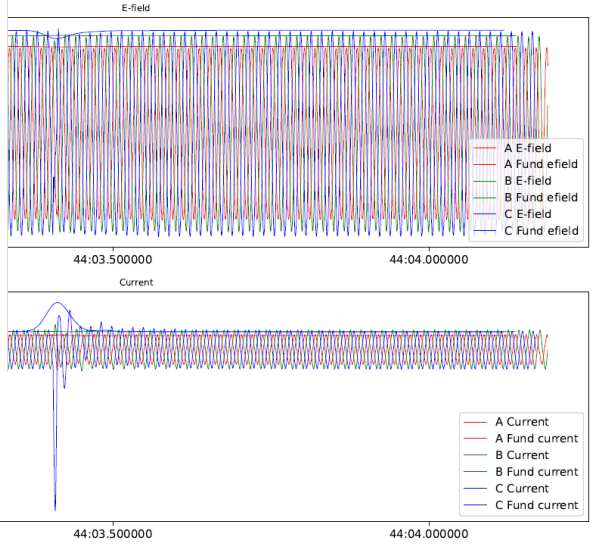


Incipient Faults









Low Amp Minor Disturbances Indicative of future failure on the utility system

- This is where things get very interesting..

Disturbances

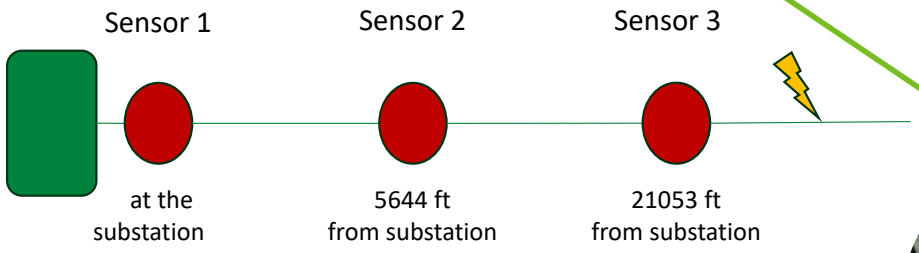
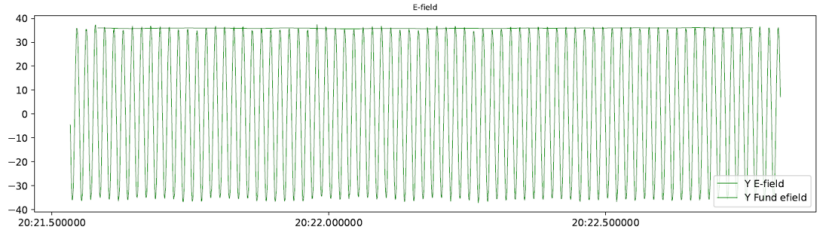
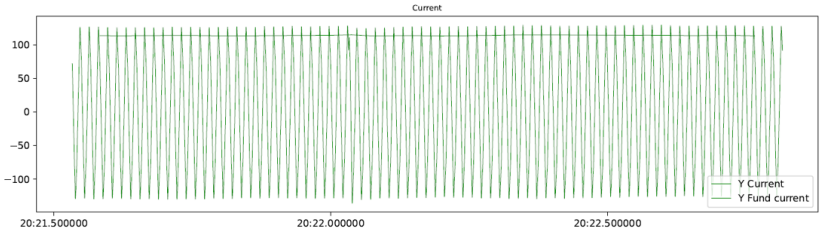
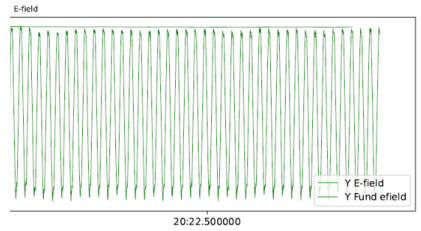
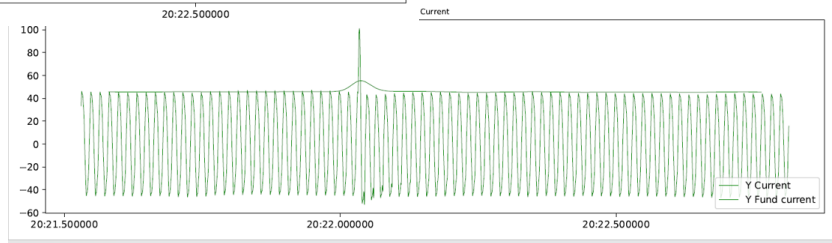


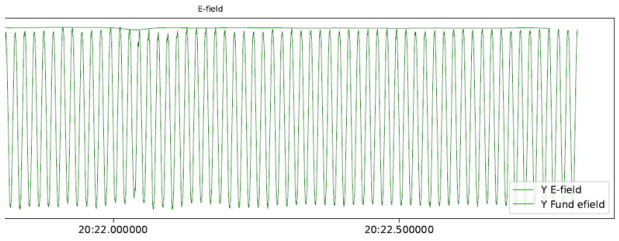
Image is just an example of the type of things found and not indicative of the signature in the waveform below

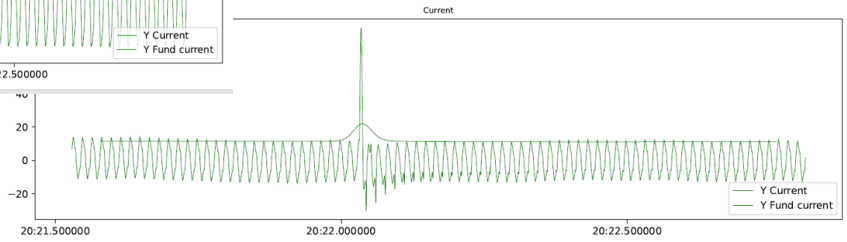






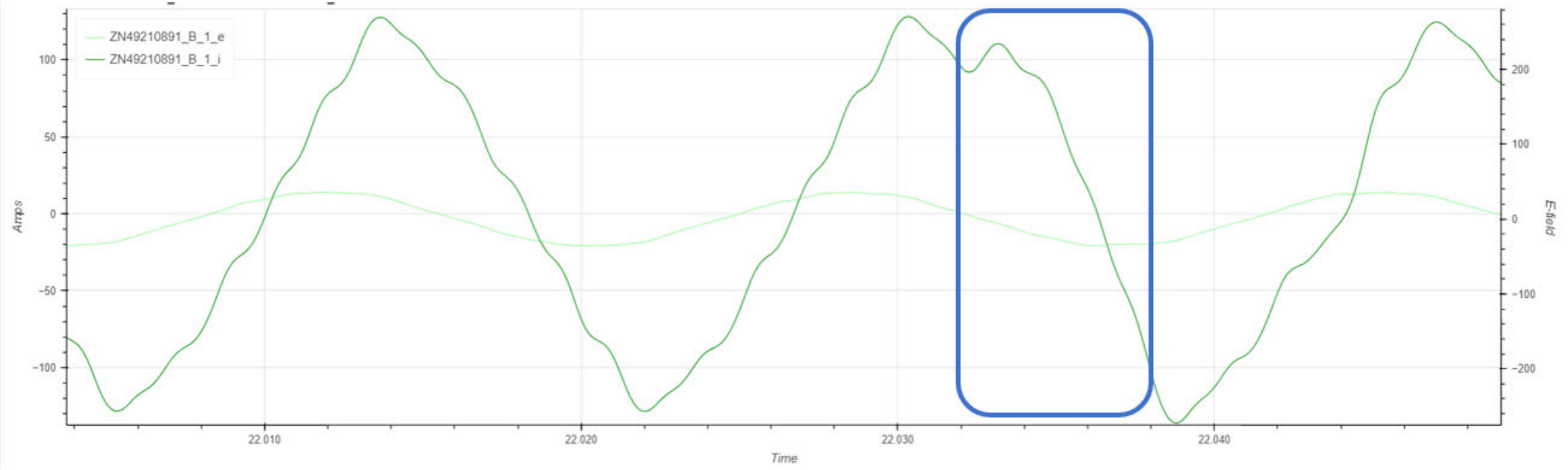






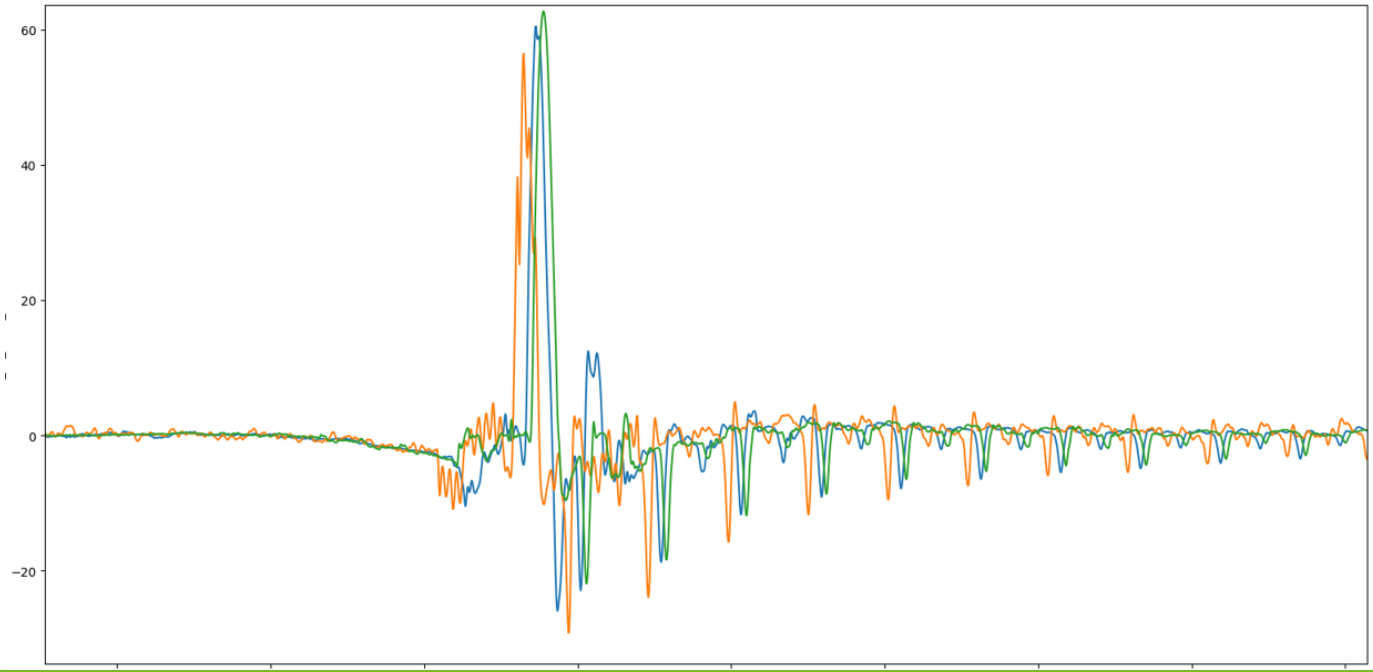
Disturbances

The disturbance is hidden in the event capture closest to the substation



Disturbances

- After some filtering and analysis, we can see the events indeed there



Observation 2

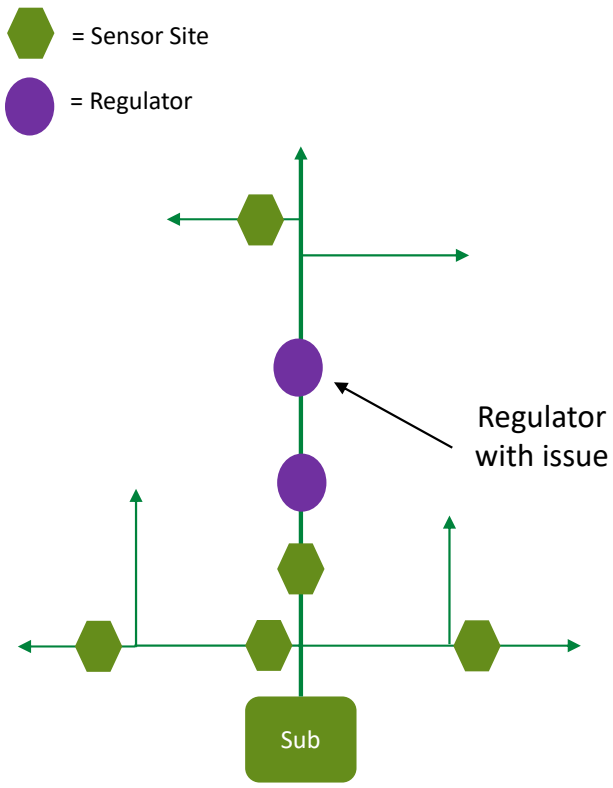
An understanding of the system (equipment, layout, environment, and measurement device) is paramount to understanding

Understanding The System

- Many times, to interpret the data in a meaningful way an understanding of the system is key.
  - Are the measurements taken on the same voltage levels?
  - Are there stepdown transformers?
  - Are the events being seen indicative of a device failing?
  - Is there environmental factors such as weather at play?
  - Other such questions…

Understanding Of The System

Onset Of Regulator Failure

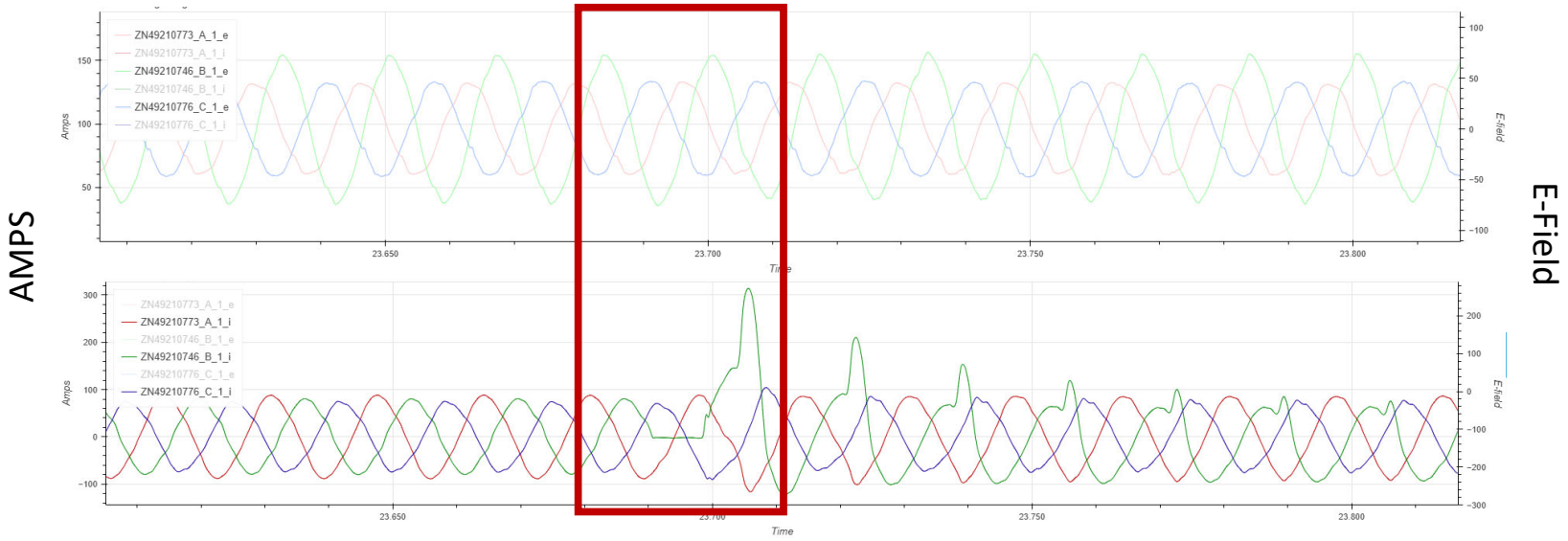


Circuit Information	
Sensor Sites	5 Sites
Sensors	8 Total
Feeder Miles	~57 Miles
OH	~56 Miles
UG	~1 Miles
3 Phs	~15 Miles
Feeder kV L-L	8.3 kV
Customers	710

Understanding Of The System

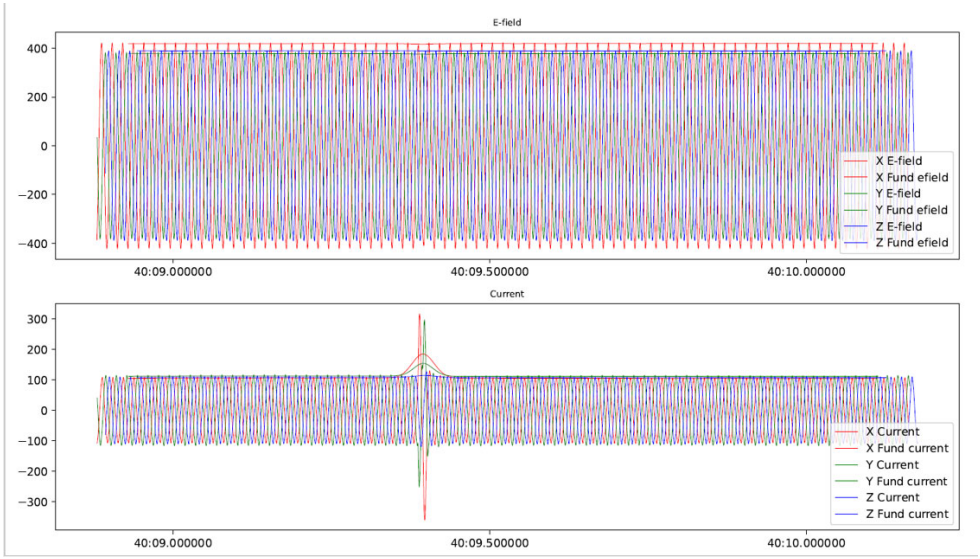
Onset Of Regulator Failure

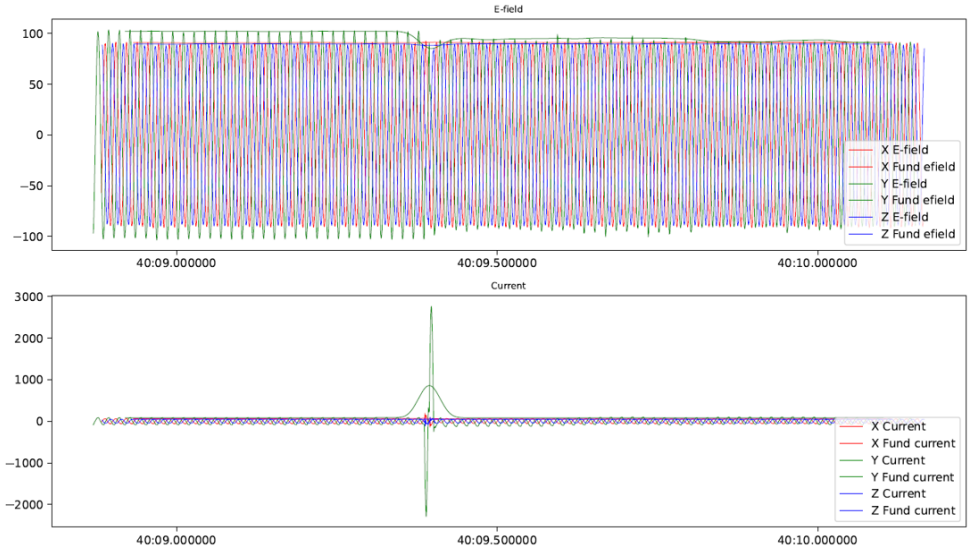
The immediate upstream sensor identified the following signature.
A fractional cycle of circuit discontinuity – A temporary break in the circuit.



Understanding Of The System

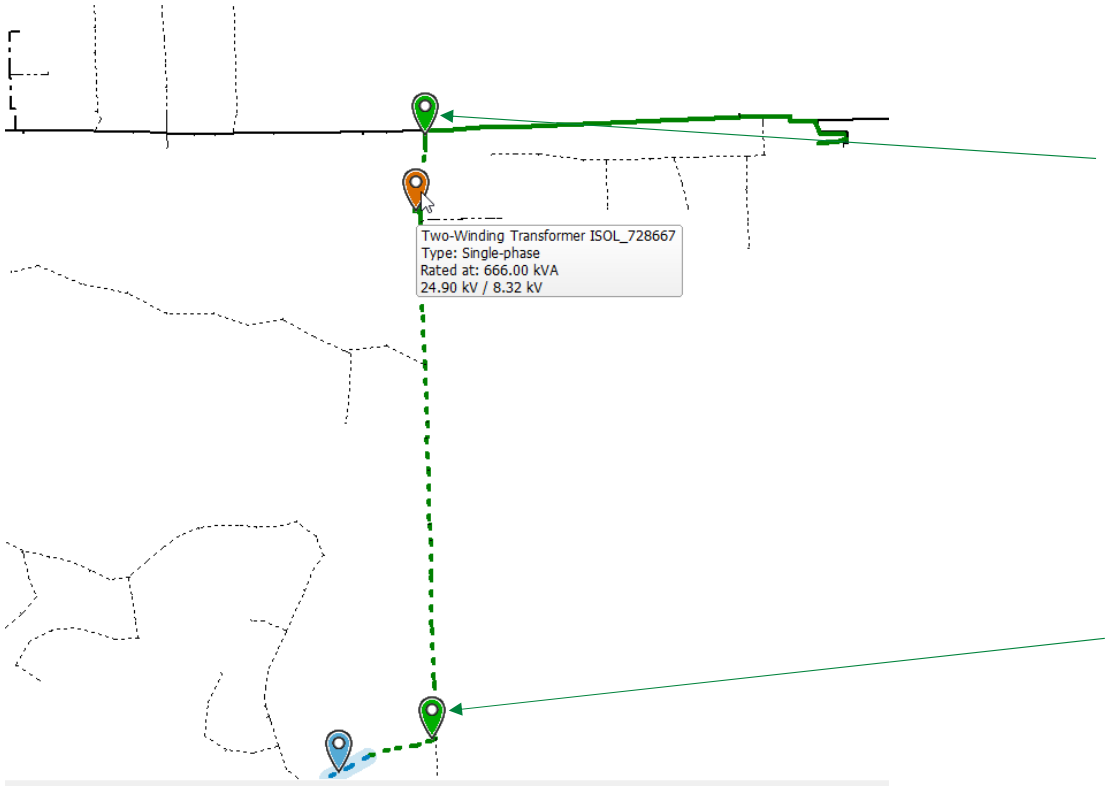
Same event across transformation

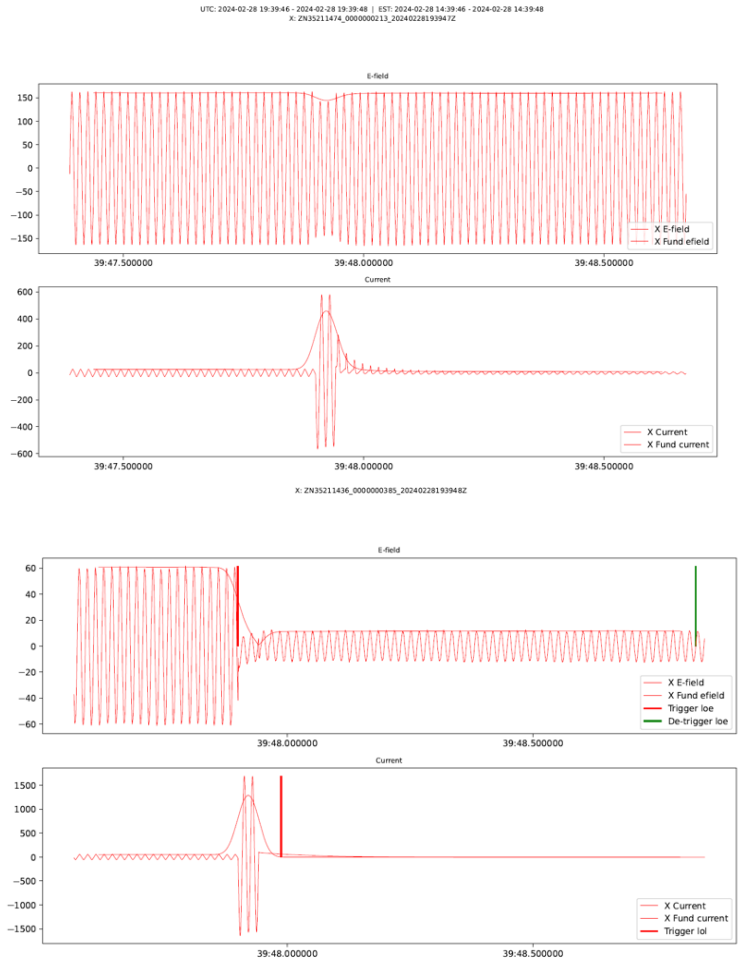




Understanding Of The System

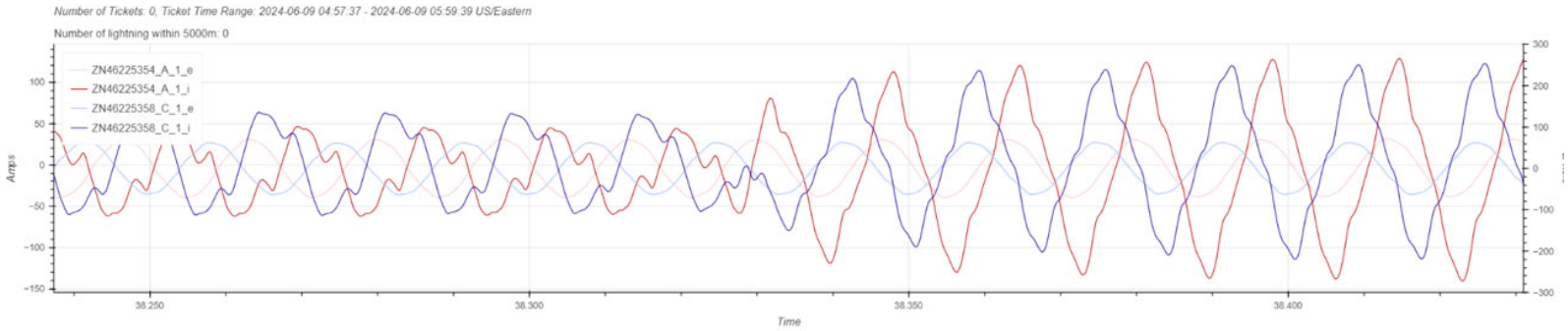
Same event across transformation



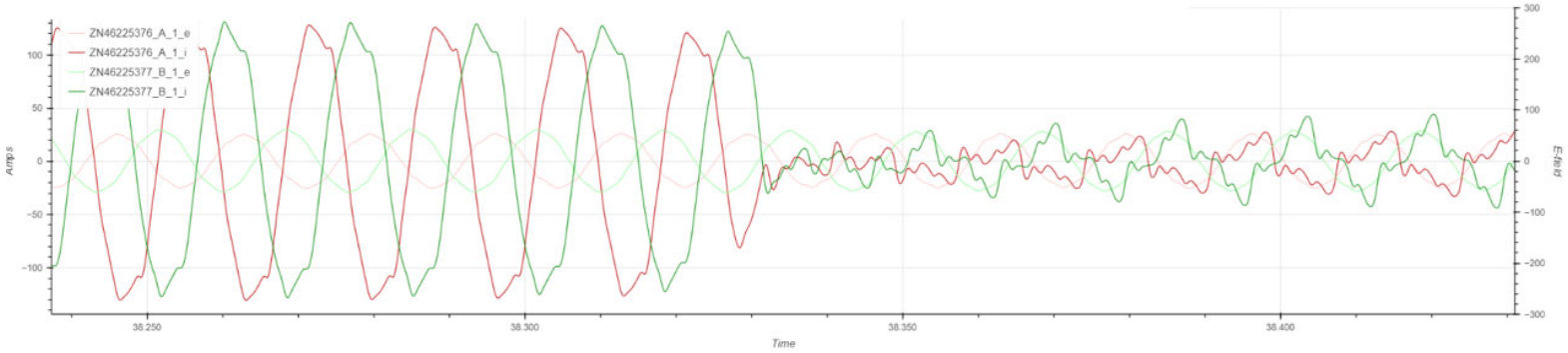


DER

Substation

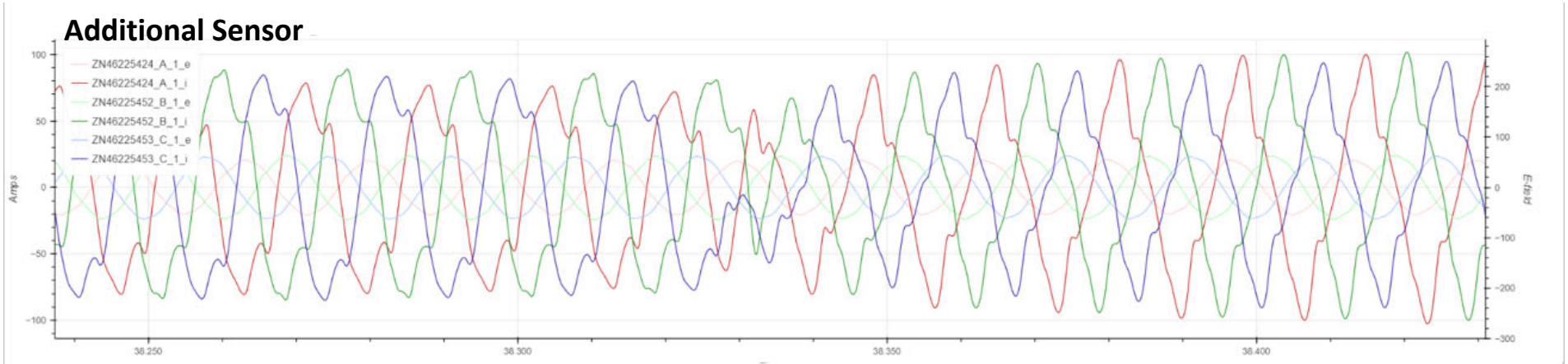


Sensor just upstream of DER

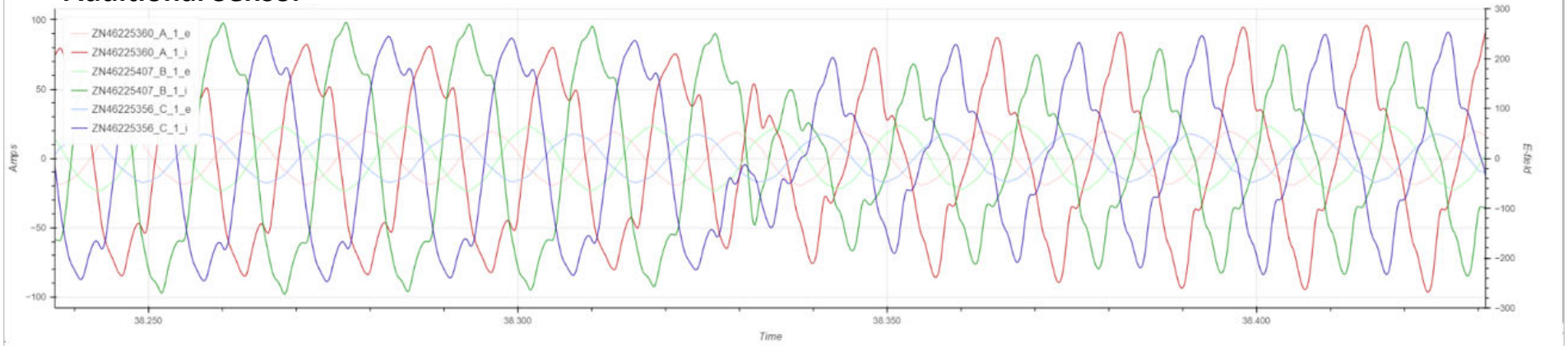


DER

Additional Sensor



Additional Sensor



Thank You