Analysis of STATCOM Oscillations using Ambient Synchrophasor Data in Dominion Energy

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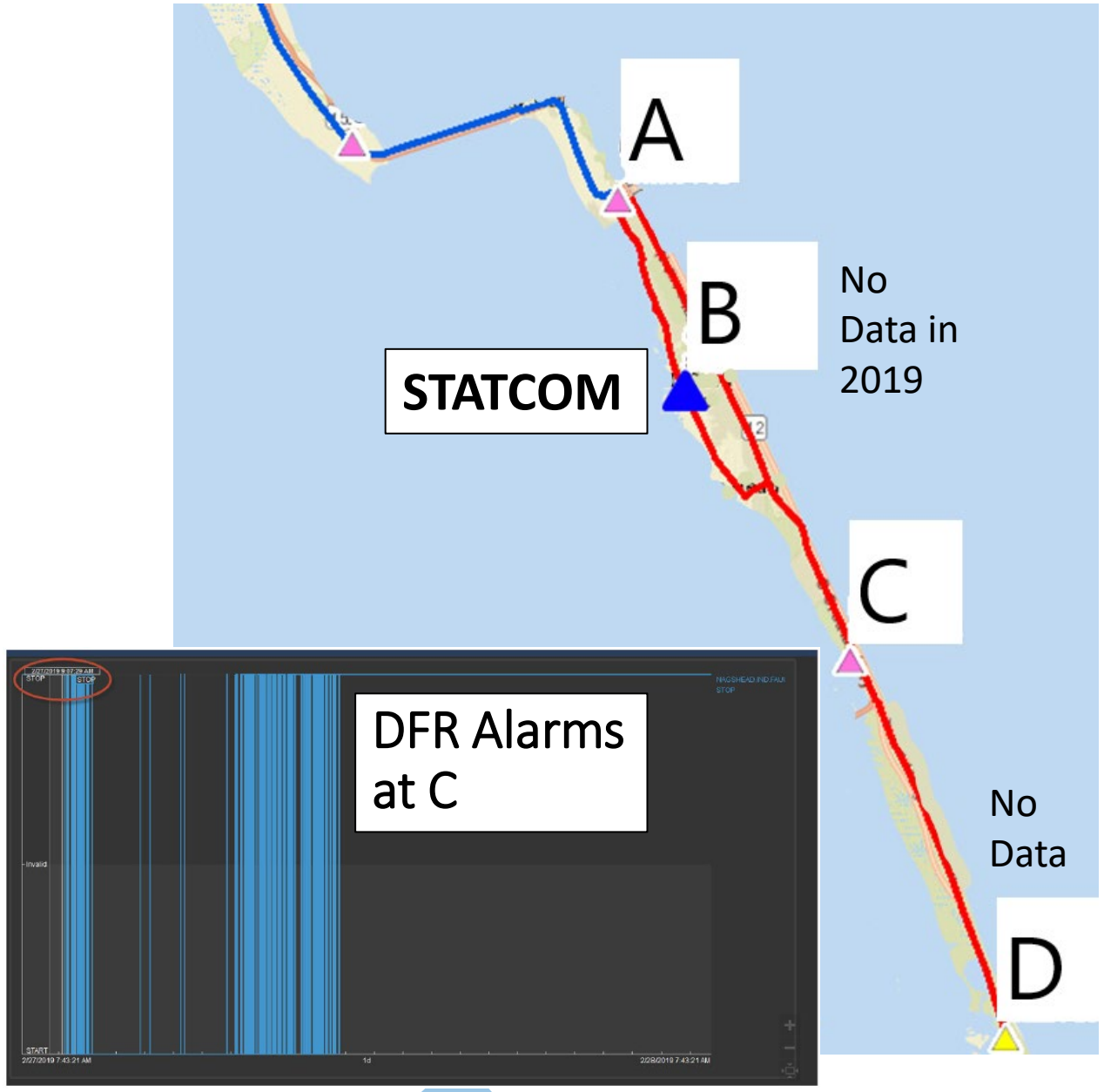
Dominion Energy

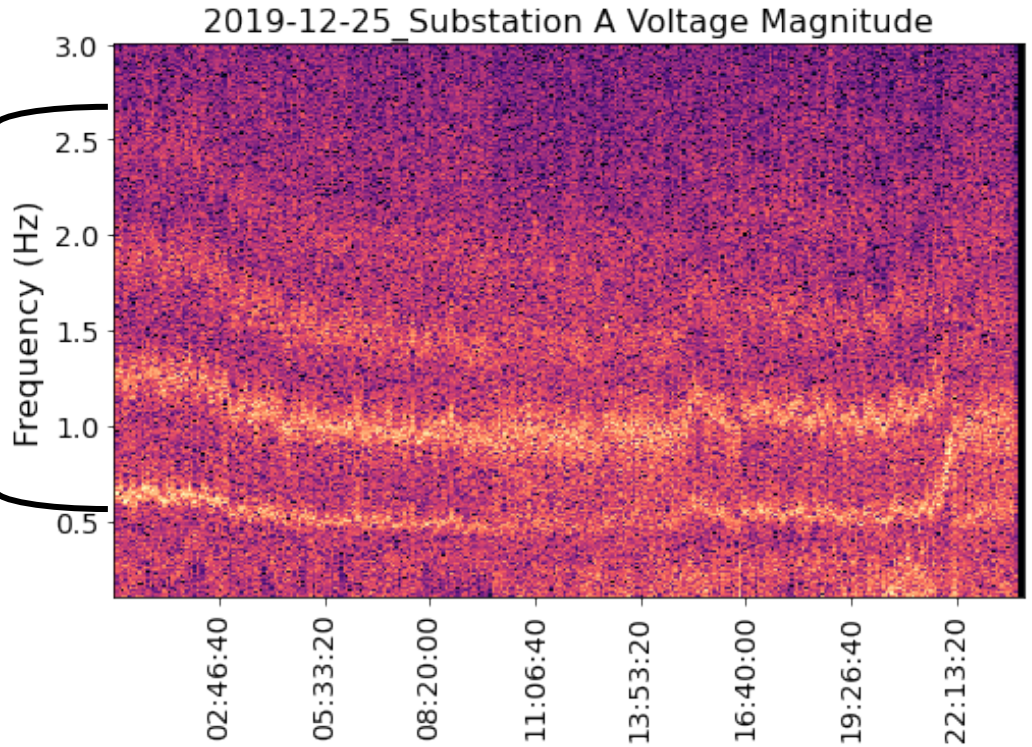
Initiating Event

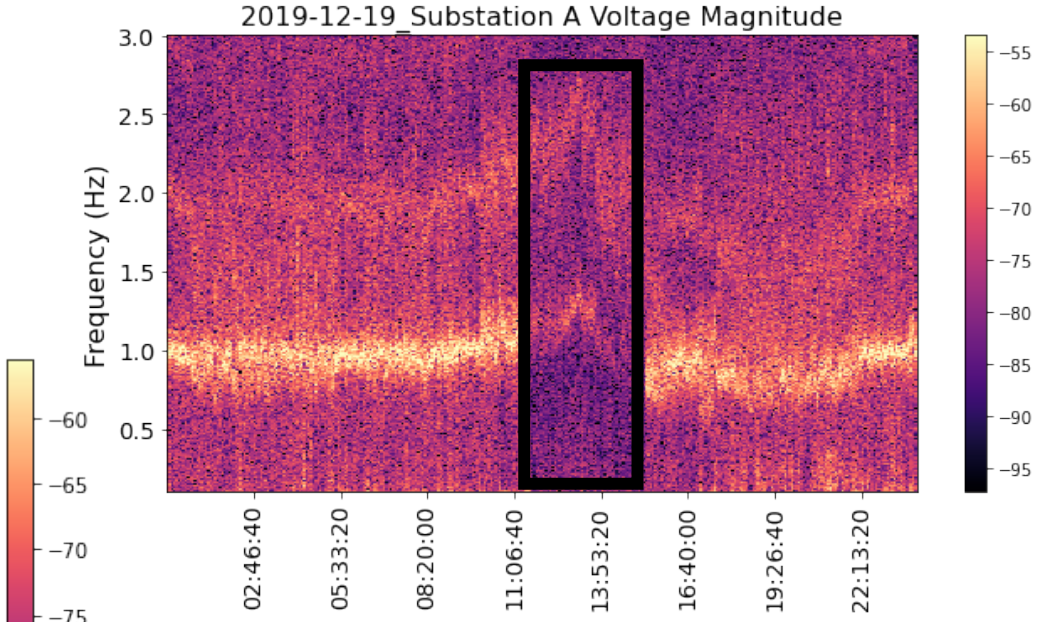
- Almost **radial**, 115 kV network with no local generation and a 125 MVAR **STATCOM** at B
- In Feb 2019, opening of line **C-D triggered DFR alarms** on THD
- Vendor conducted **root cause analysis** using a PSCAD model
  - Recommendations to turn off a control function in weak conditions
  - Brushed off as a one-off event
- What if the issue **was always there** ?

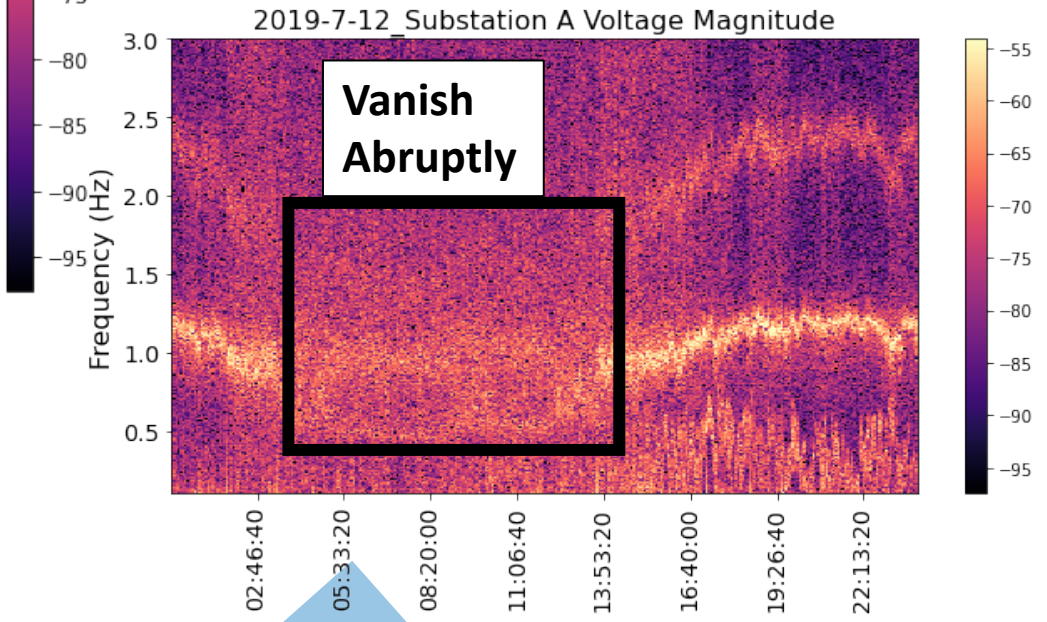


Long Term Analysis

Potential harmonic set







Voltage magnitude at Substation A on Line A-B best observed the oscillations, chosen for analysis

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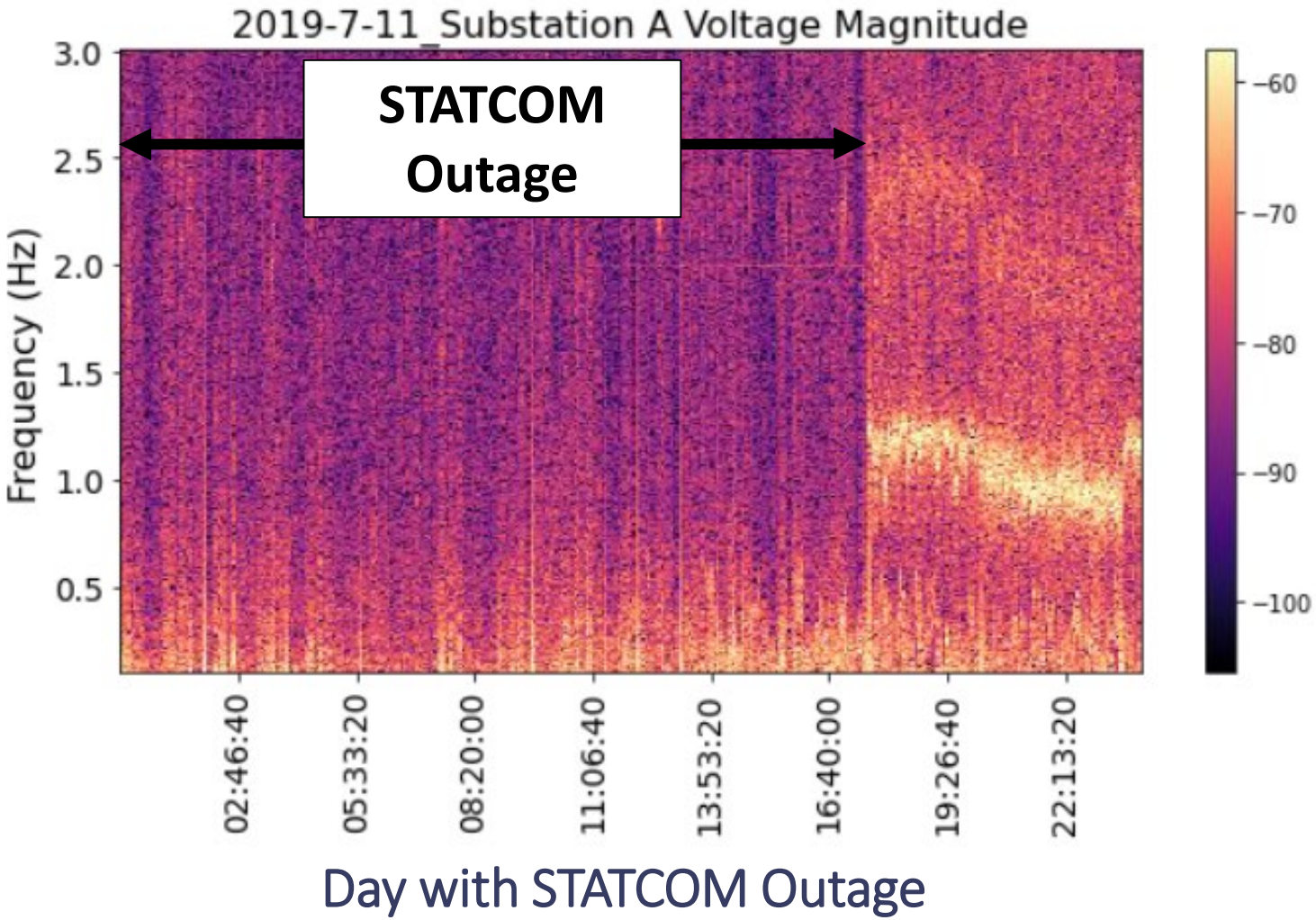
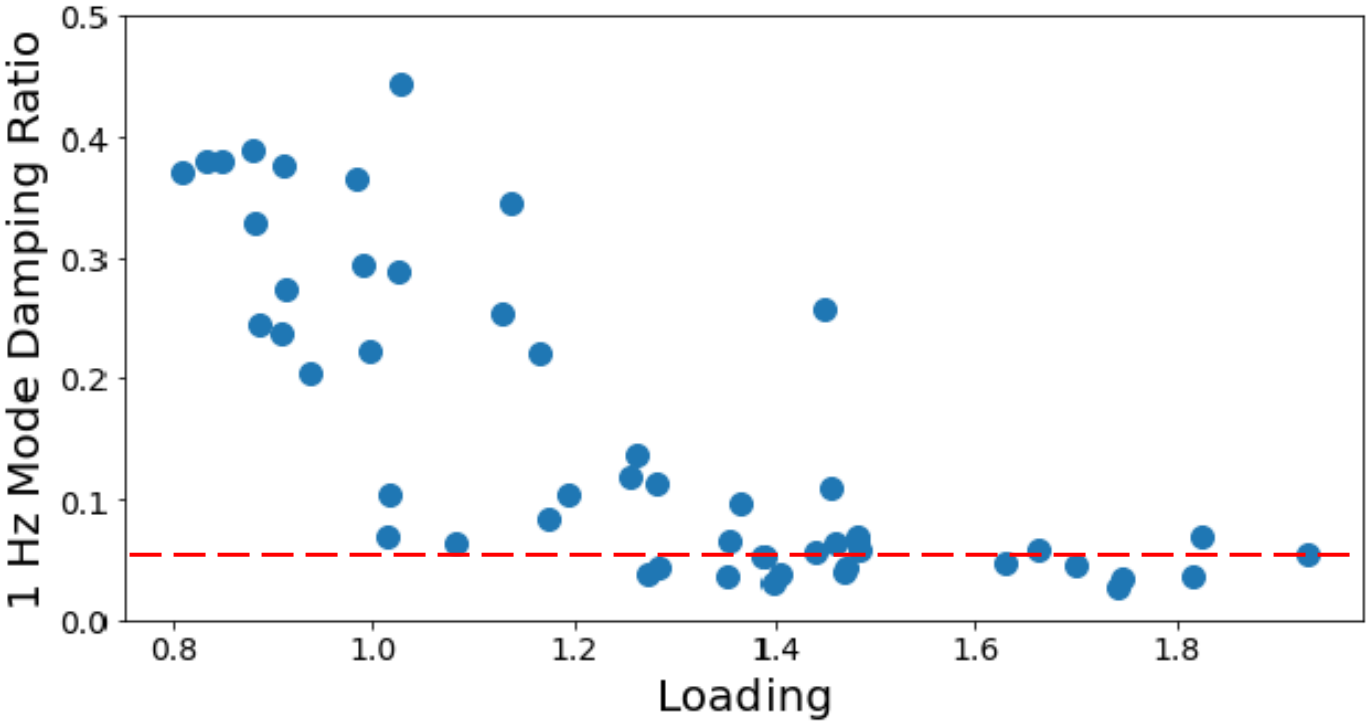
Source ?

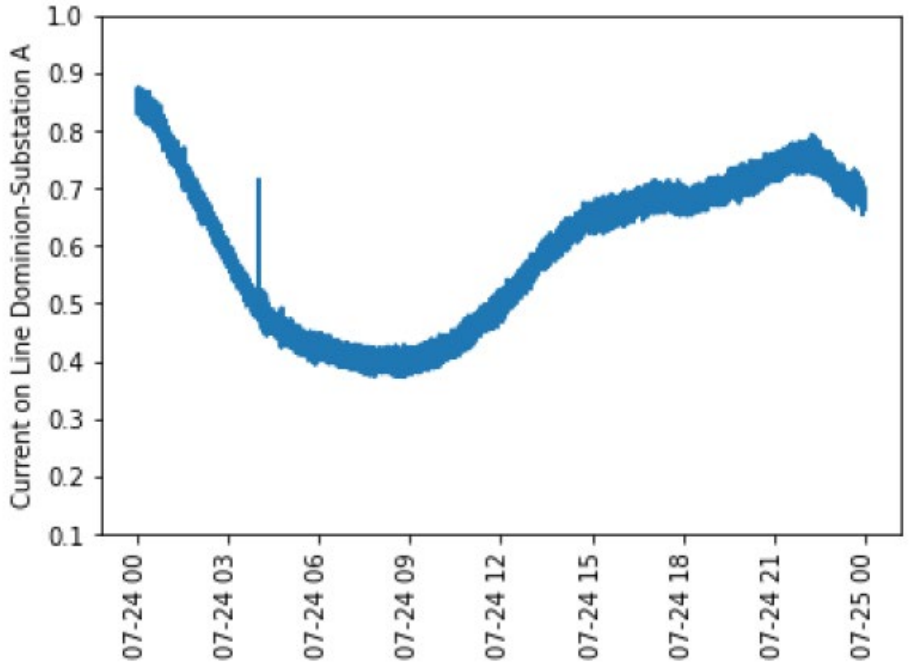
- No other BES dynamic resource in that area besides STATCOM at B
  - Have observed dynamics from industrial customers at distribution level in other places
- Measurements not available at B in 2019
  - Mode shape couldn't help choose between A and B
- Correlated STATCOM outage schedule with mode observability to determine the cause



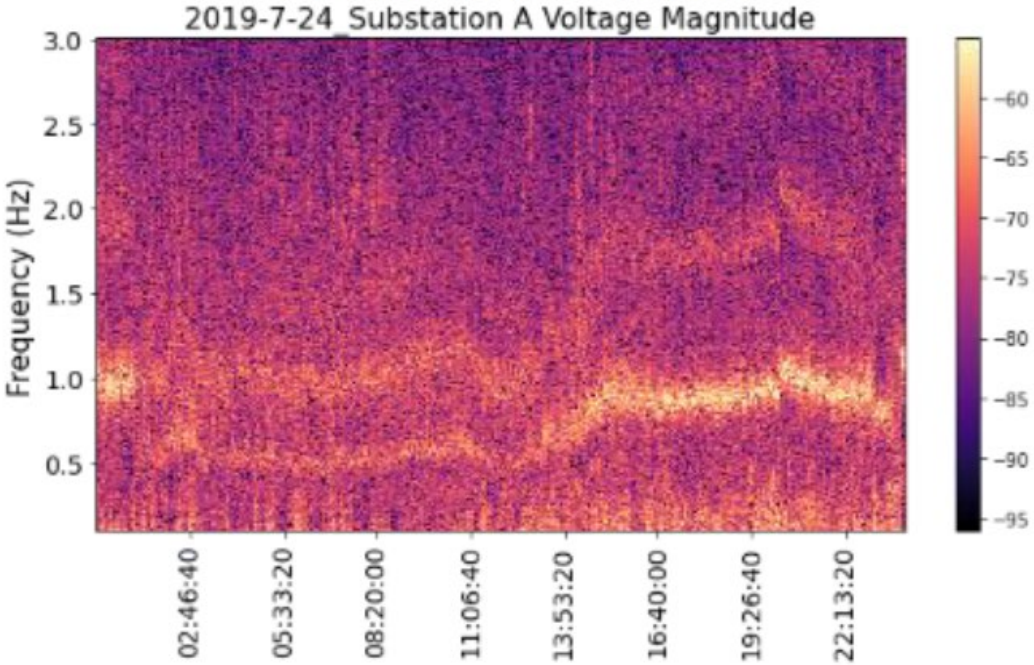
Mode Trends and Characteristics



Damping Negatively Correlated to Loading (Aug 2020 Data)



(a) Current in p.u. in Line A-B



Identifying Specific Cause

- Additional control schemes in the STATCOM
  - No Load Standby (NLS) makes STATCOM output zero Q during normal conditions (set separately)
  - Negative sequence control (NSC) helps balance,
    - STATCOM individual submodule voltages (besides circulating current)
    - Transmission system imbalance
- Need accurate model or controlled experiments in the field to identify the problematic control design
  - Need to model rest of the system's behavior

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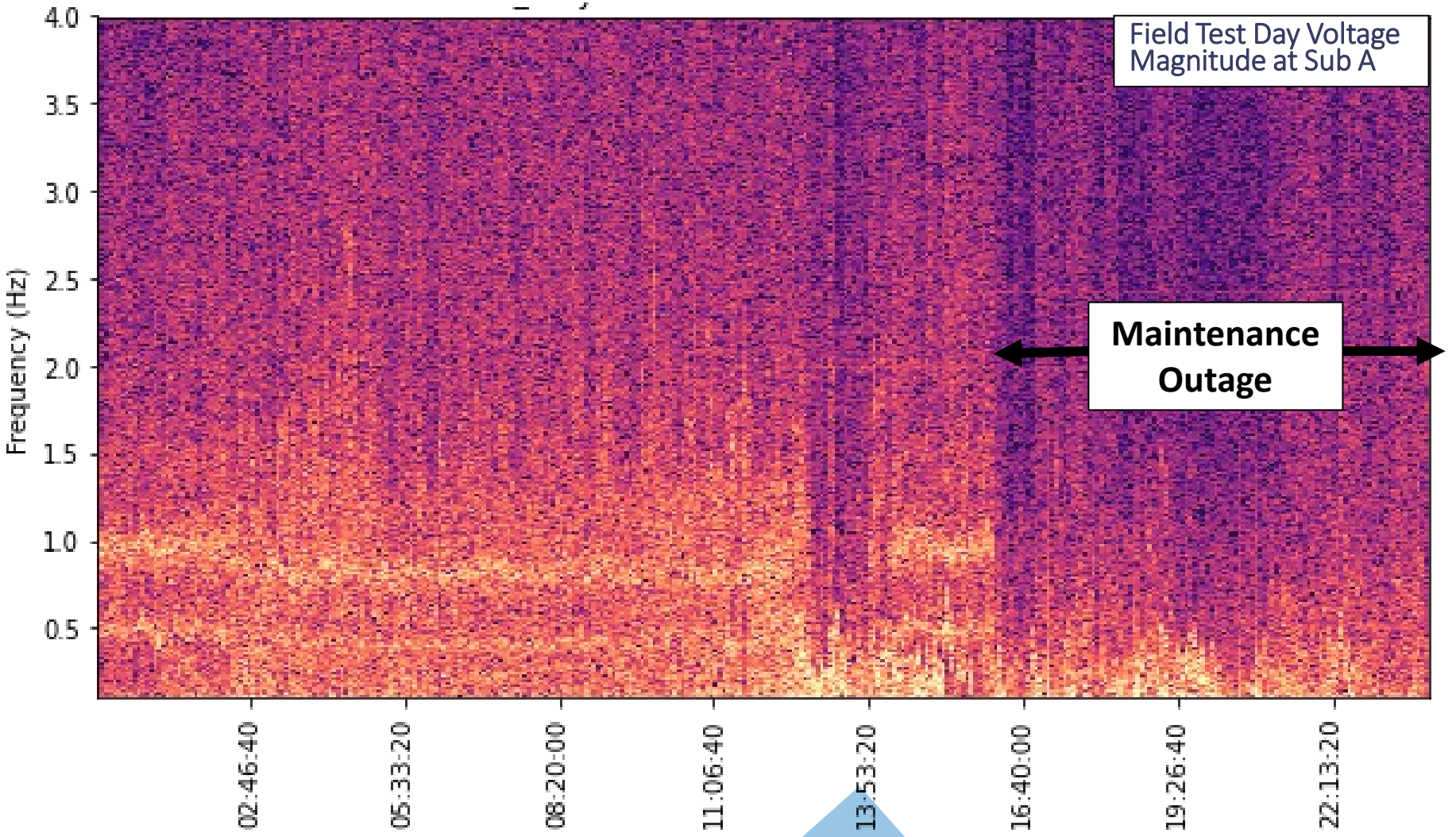
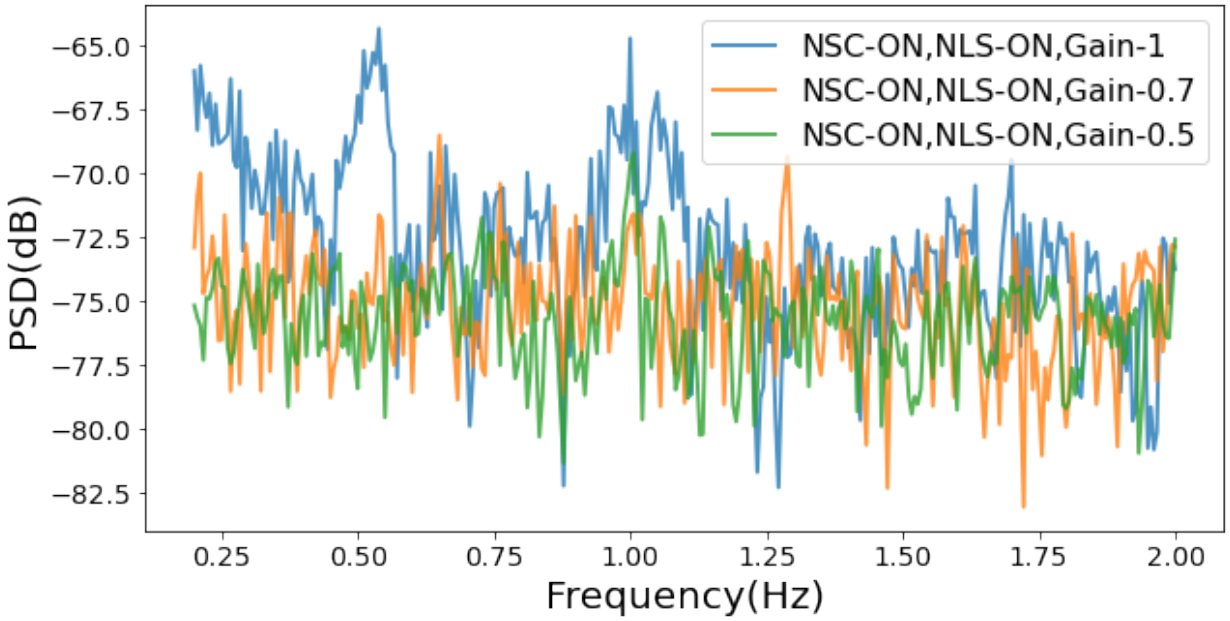
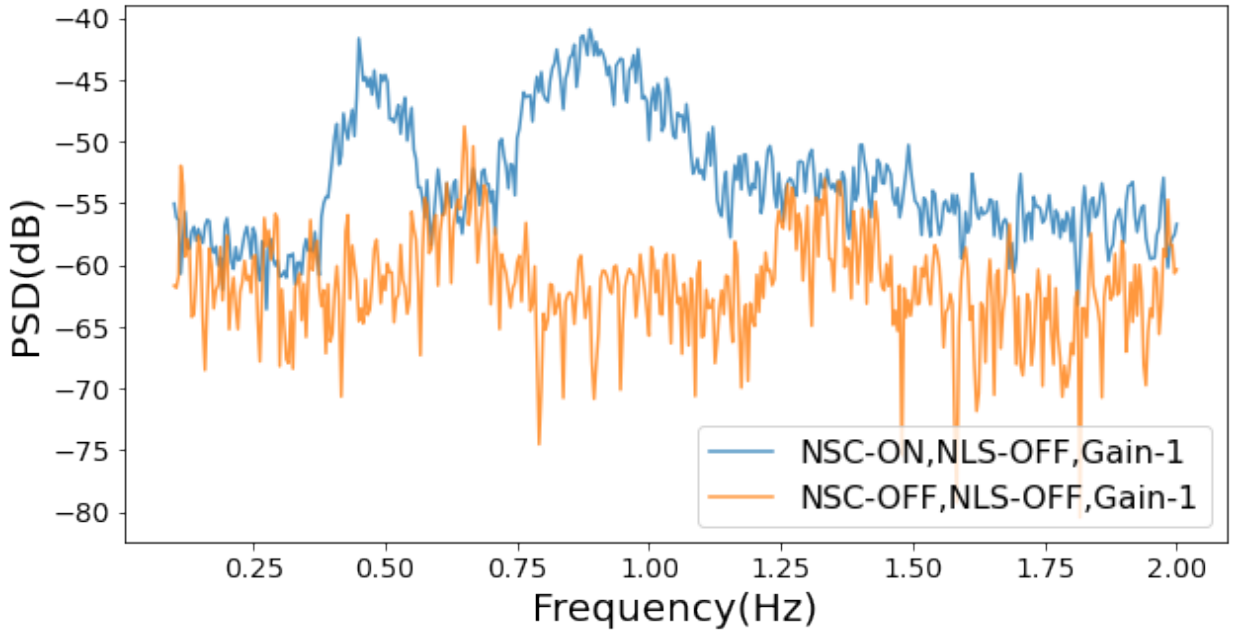
Field Test 2020

- NLS ON/OFF
- NSC – ON/OFF
- Gain Ramped Down





Reducing Gain Diminishes Mode (Expected)



Switching OFF NSC Damps the Mode

Key Takeaways

- Cannot wait for large events to expose issues in the system
- One set of control settings may not work well for the whole year, need to adapt
- To fully explain the case, need better models and/or ability to do online experiments

Thank You !