Radio Frequency Mass Gauging using Machine Learning

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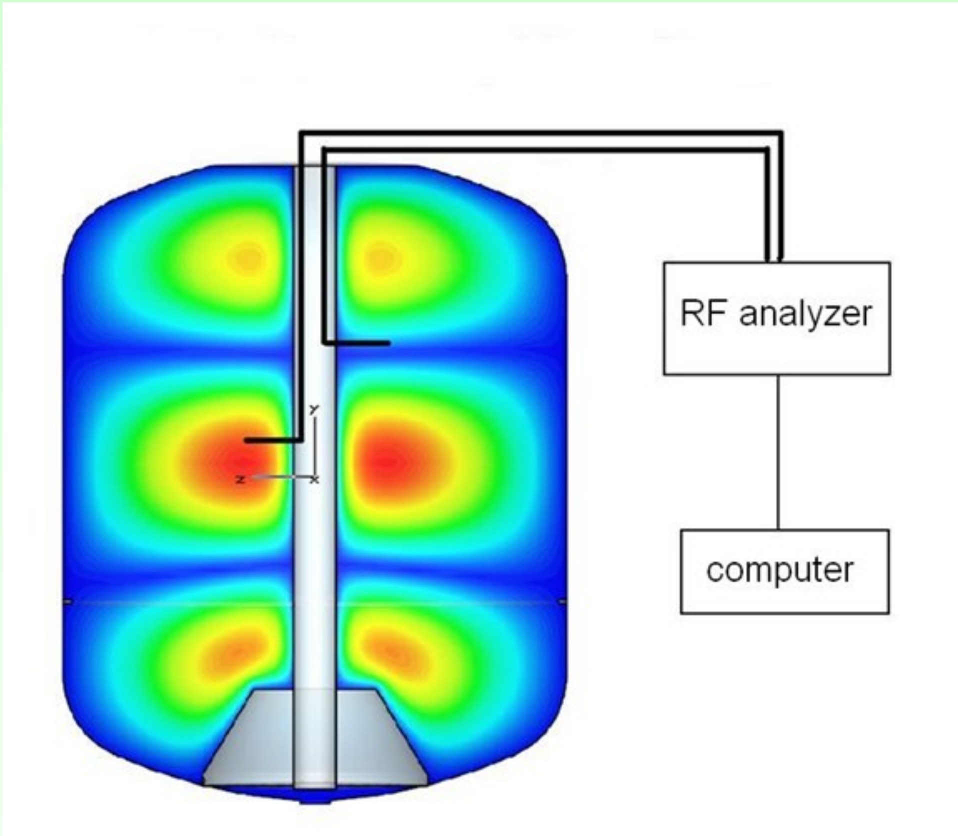
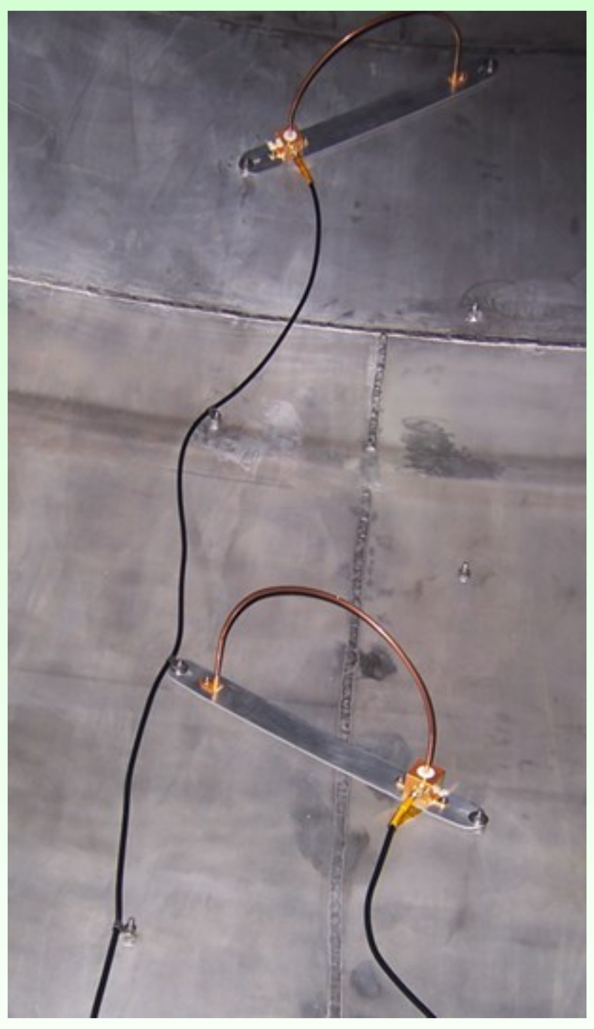
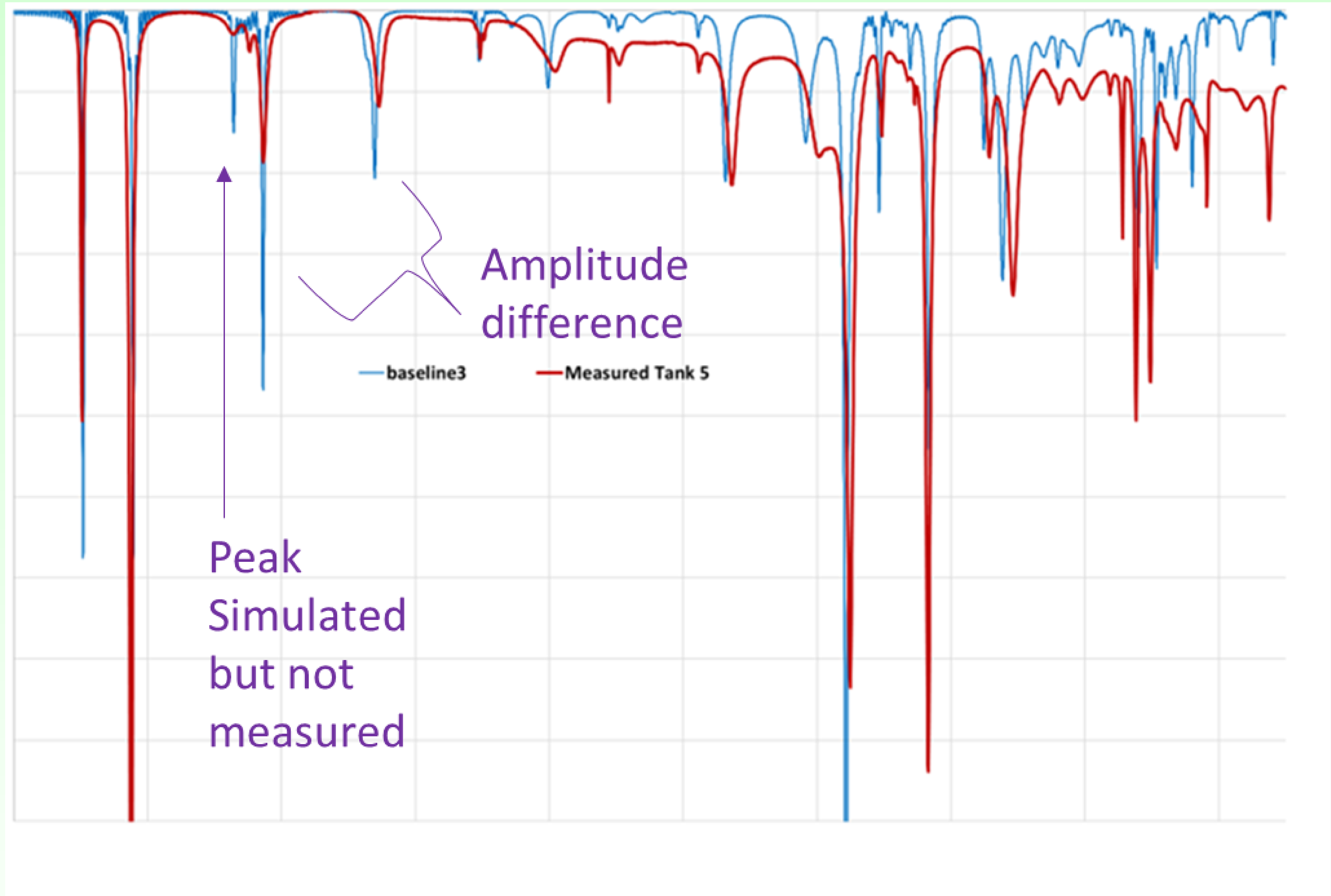


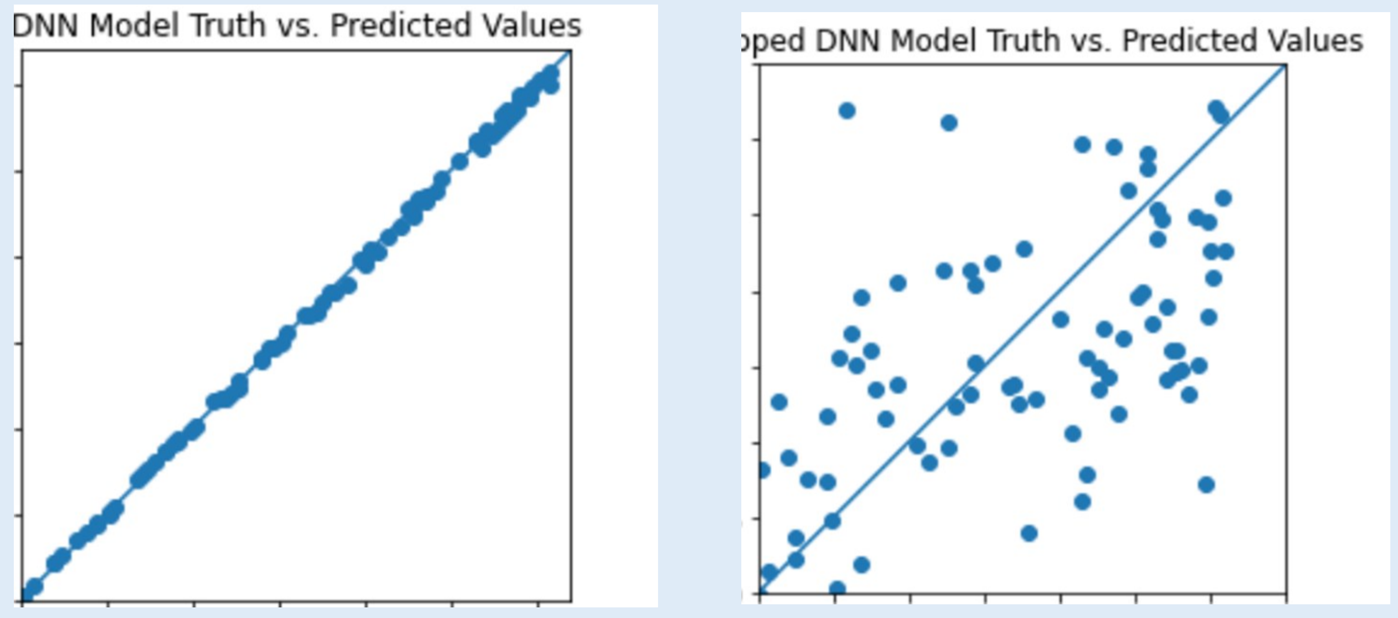
$$f_{full} \sim f_{empty} / \sqrt{\varepsilon}$$



Example of Simulation vs Real



- Antennas placed in the tank measure the RF spectrum, which changes with fill level since the dielectric fluid (e) slows the speed of light
- The basis of the RFMG is that these changes can be accurately predicted via RF/fluid simulations (e.g., Comsol or CST Studio)
  - NESC-RP-20-01603 page 50, the NASA Engineering and Safety Center (NESC) identified an area of complex development for RFMG to be "Generation of simulations for all fluid configurations expected during gauging operations".
- Data is generated through "sweeps" during which the antenna emits a range of signals, from
- Dips in response frequencies occur at resonant frequencies based on the tank dimensions and the fluid
- By tracking the resonant frequencies (also referred to as peaks or eigenfrequencies), the entire sweep can be reduced into a few dozen datapoints



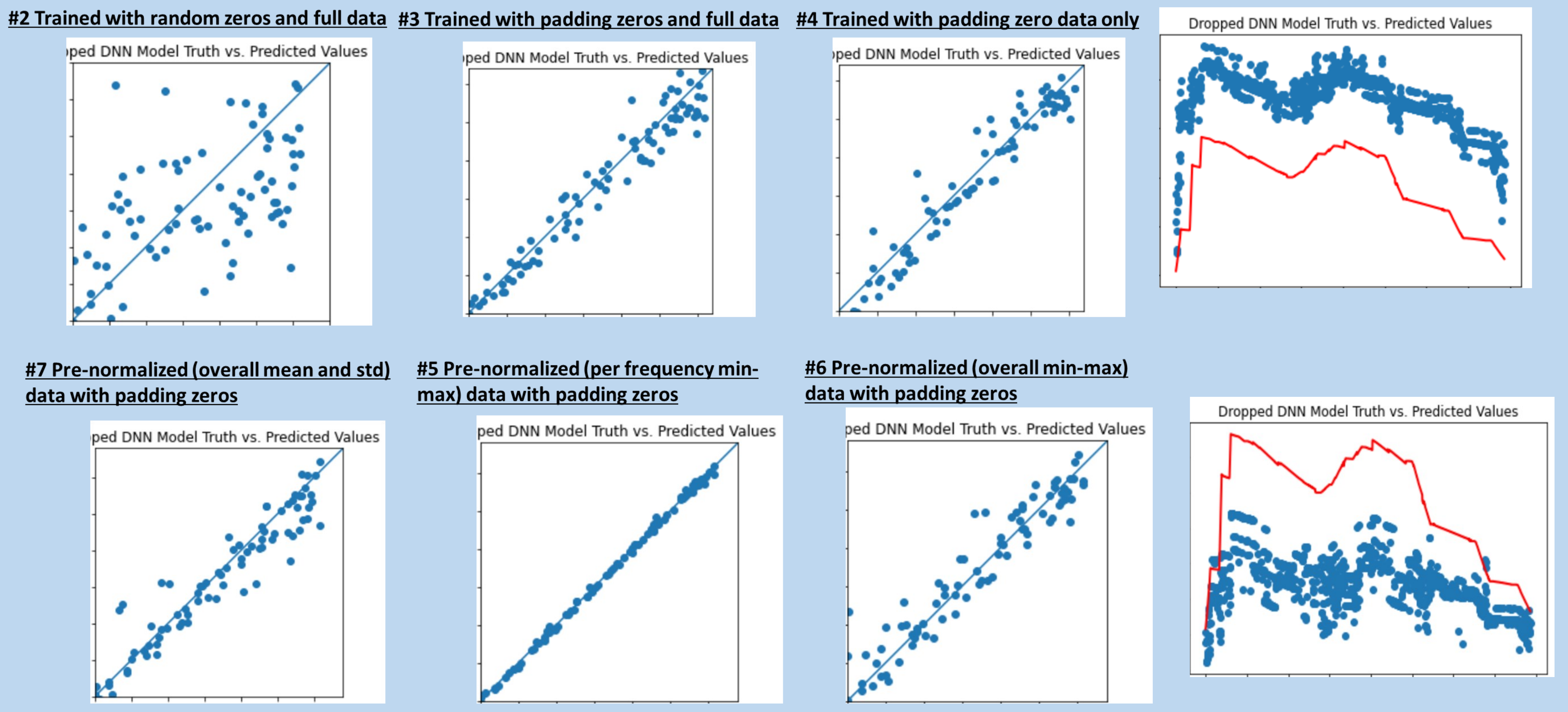
Sanity check

Simulation perfect but real measurements missing

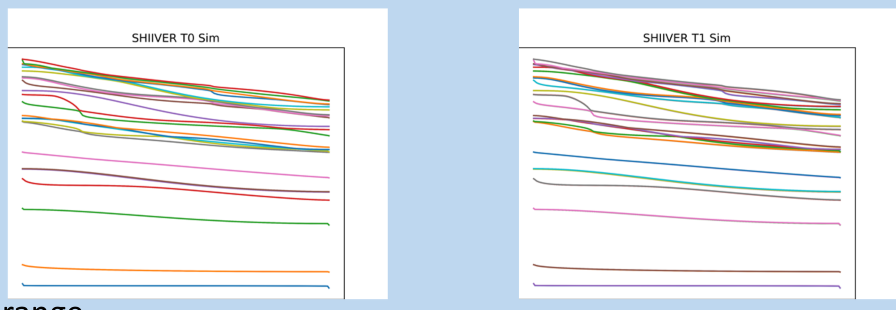
Initial Work

Examples of attempts that always had a consistent problem.

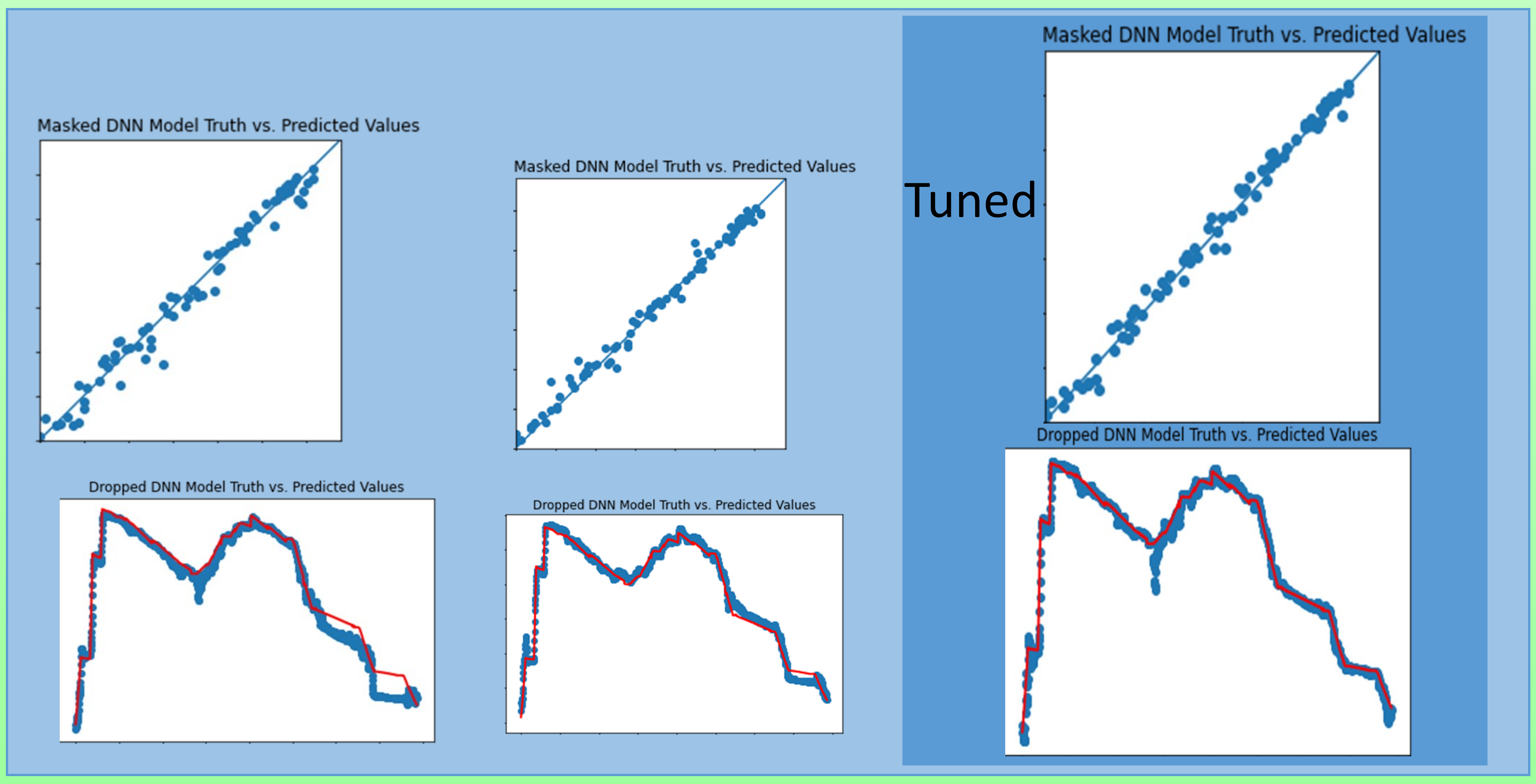
Data needs to be understood for ML to work



- Consistent problem with data offset and understanding…
- Spent time with GRC understanding data and limitations
  - Discovered that we should only consider a certain frequency response range



Results



Results on Second Test