

CORTEX

Core monitoring techniques and
experimental validation and demonstration

Feature Extraction & Identification Techniques for the Alignment of Perturbation Simulations with Power Plant Measurements

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Overview

- We propose a methodology for the comparison of measured and simulated neutron noise signals in nuclear power plants
- The key components of the proposed methodology are:
 1. Auto-Power Spectral Density of plant measurements in order to identify possible perturbation frequencies
 2. Cross-Power Spectral Density between plant measurements and simulated data in order to identify possible perturbations
- Reactor core used in this study is a German 4-loop pre-KONVOI Pressurized Water Reactor



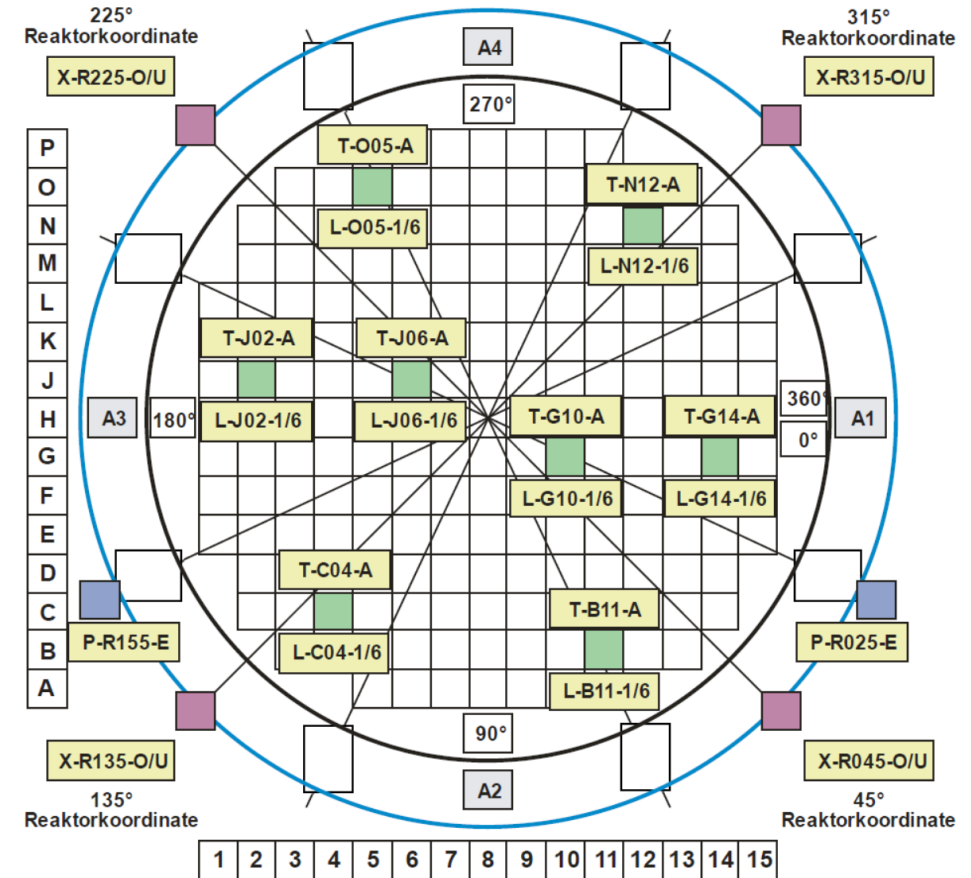
Neutron Noise Signals: Simulated Data

- Frequency-domain simulations using the CORE SIM+ tool
- Anomalies/perturbations considered
 1. Axially traveling perturbations at the velocity of the coolant flow
 2. Fuel assembly vibrations
 - Cantilevered beam mode, simply supported on both sides mode and both
 - All possible locations of the vibrating fuel assembly have been modelled
 3. Core barrel vibrations (beam & pendular modes)
 4. Generic "Absorber of variable strength"
 - Spatial Dirac-like perturbation



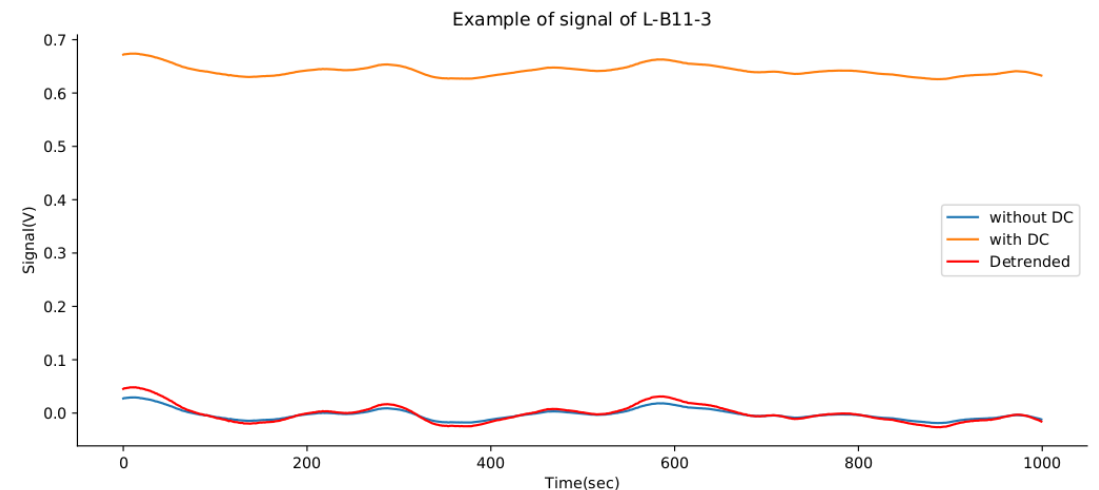
Neutron Noise Signals: Plant measurements

- German 4-loop pre-KONVOI Pressurized Water Reactor
- Detector Types
 - in-core (L), thermal (T), ex-core (X), pressure sensors (P)
- Only neutron noise sensors have been considered in this study
 - 53 sensors in total (45 L & 8X) as some were known to exhibit faulty behavior

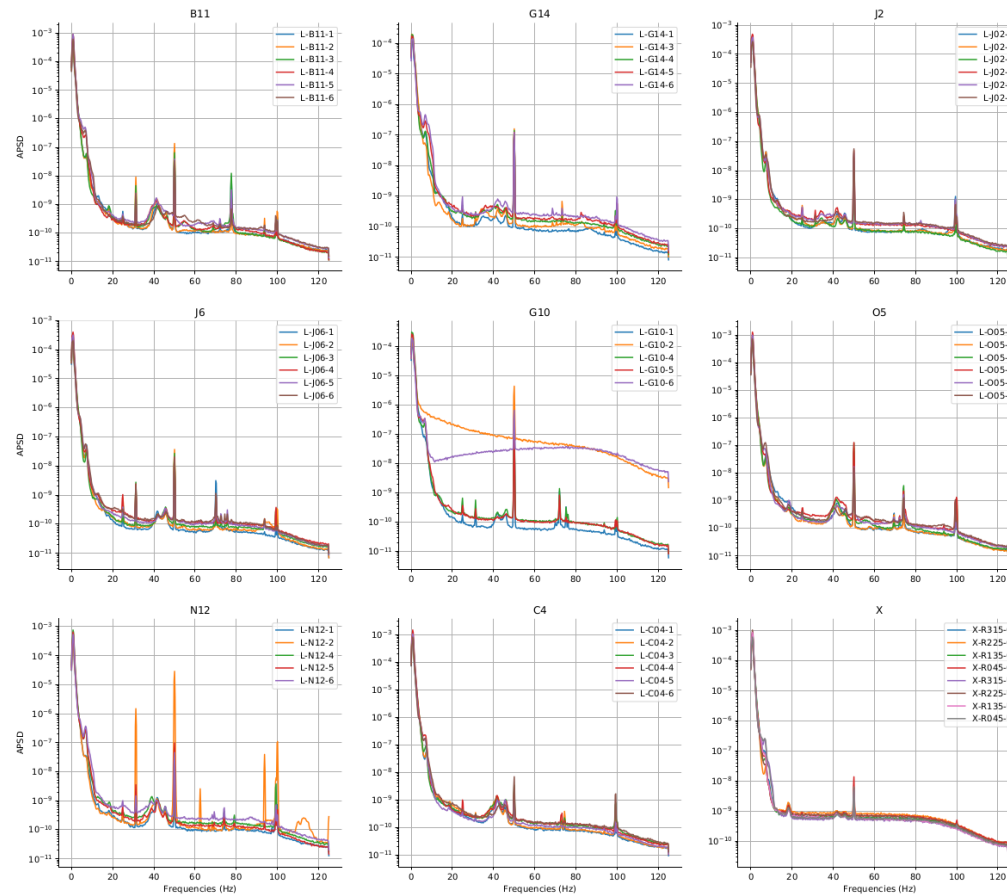


Plant measurement signal preprocessing

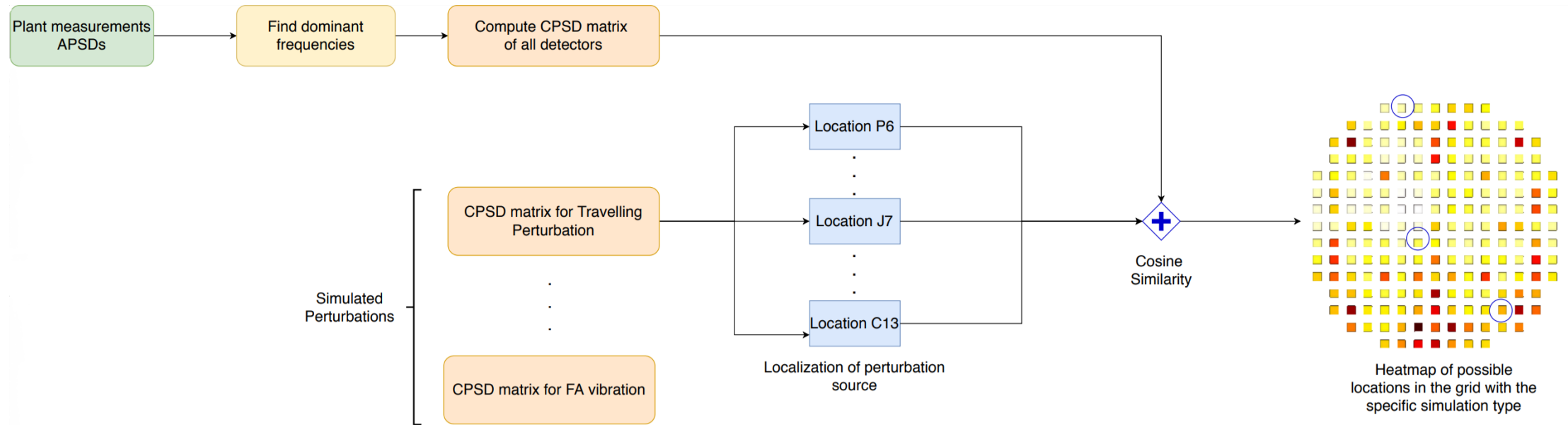
- Signal
 - length: 30 minutes
 - Sampling rate: 250Hz
 - 450,560 discrete time samples
- Preprocessing steps
 1. Remove the DC component
 2. Remove trend, if present



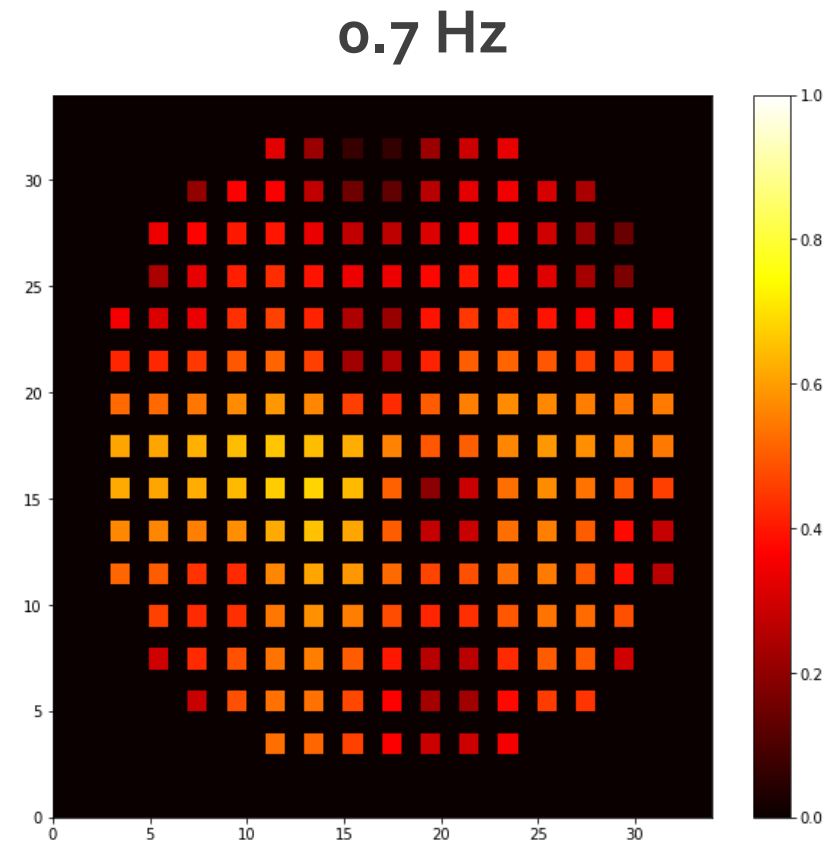
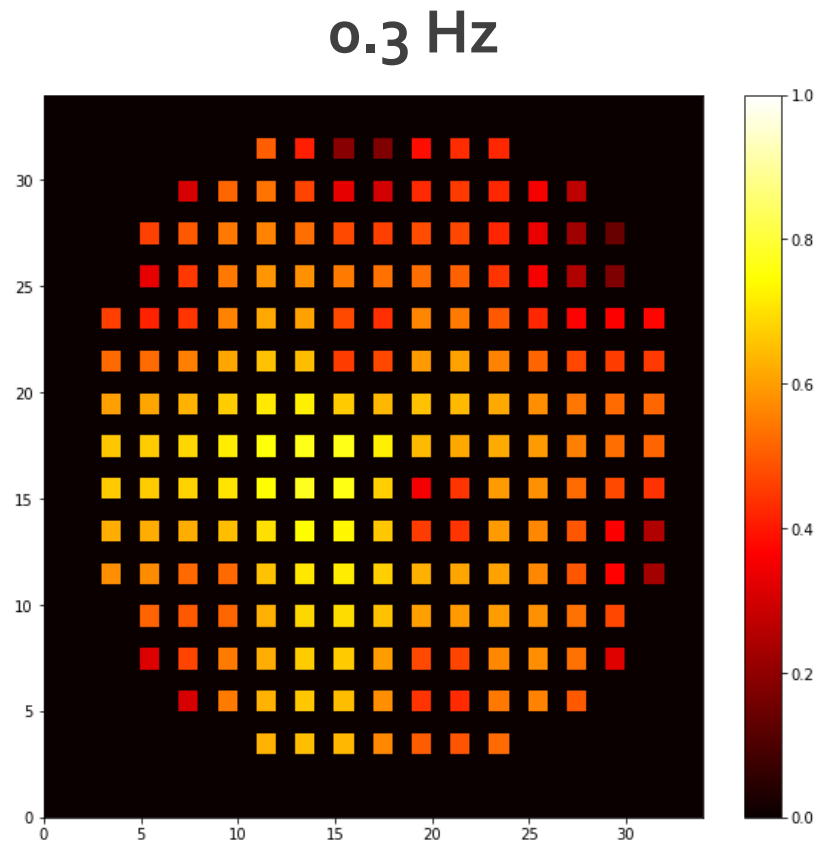
Auto-Power Spectral Density of plant measurement signals



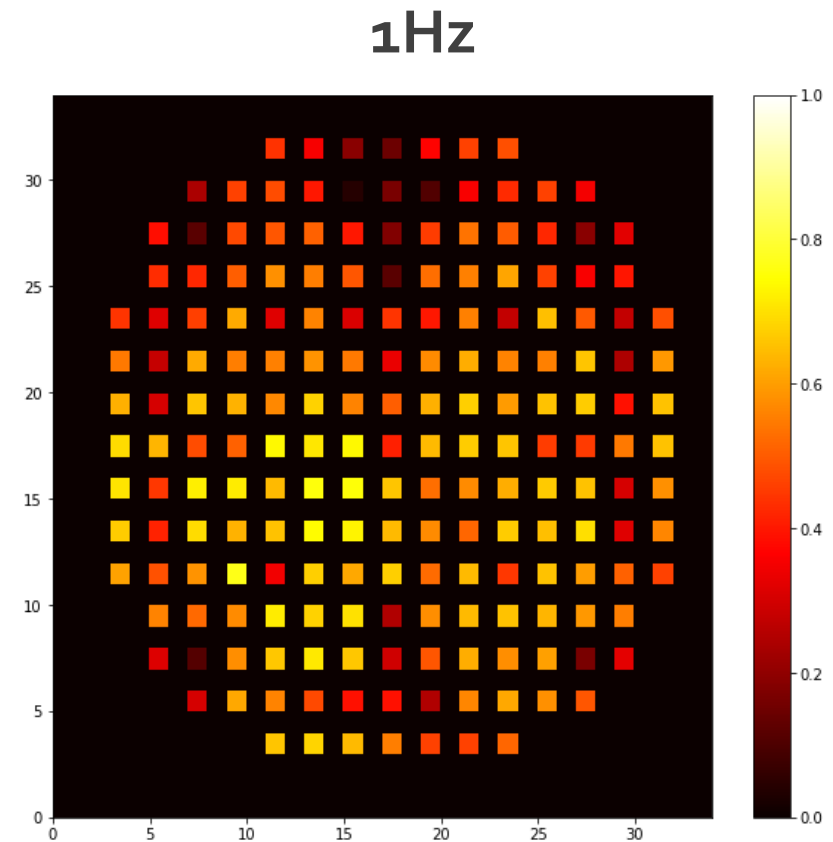
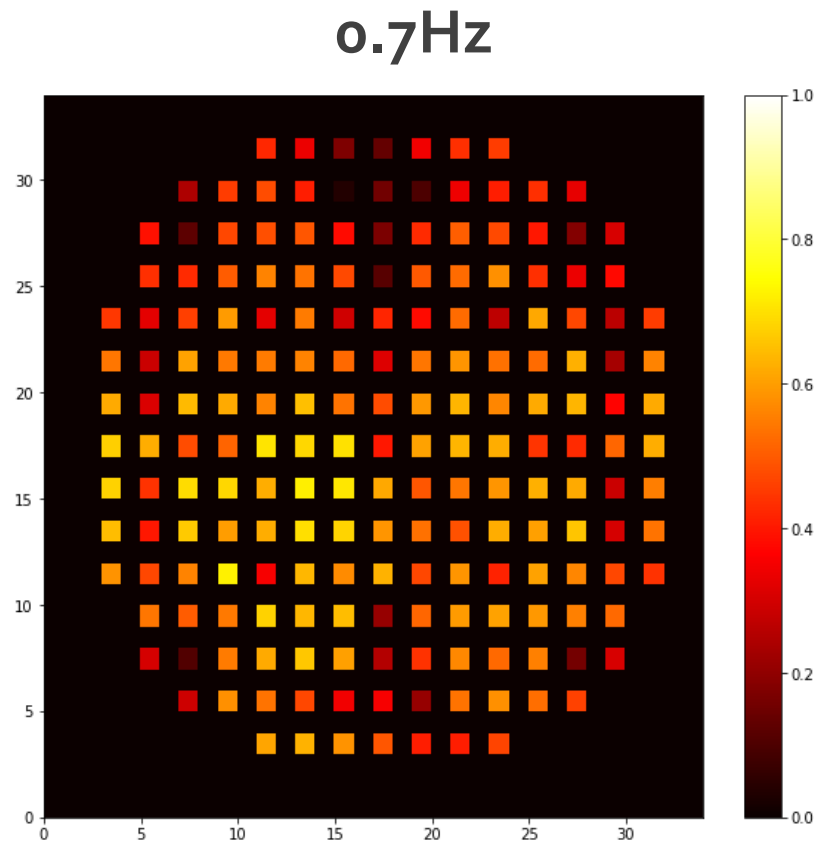
Comparison pipeline



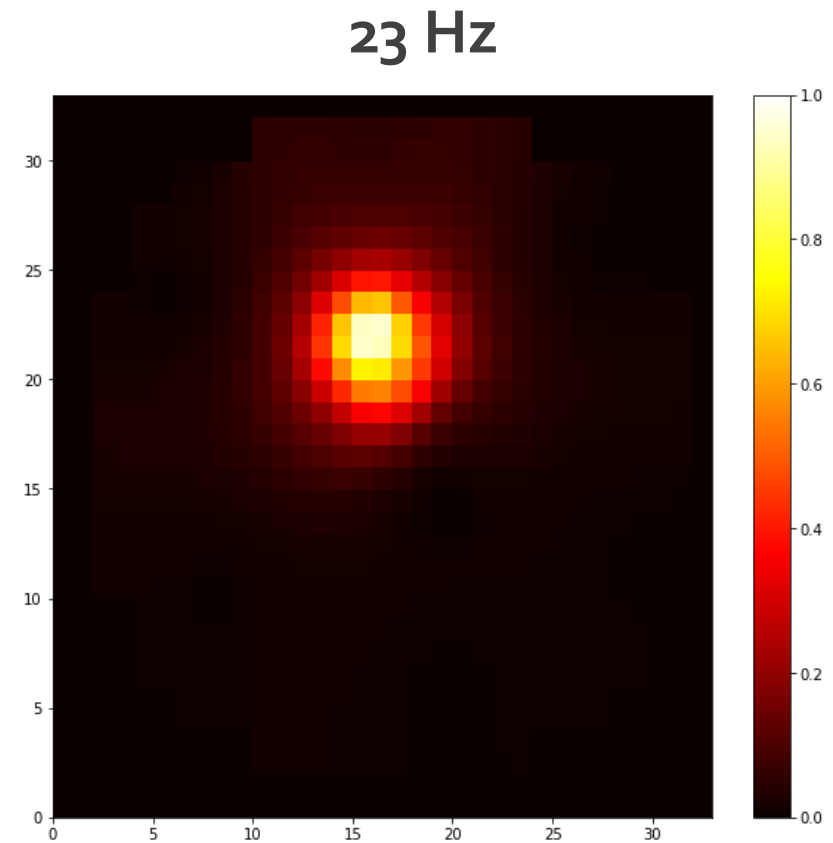
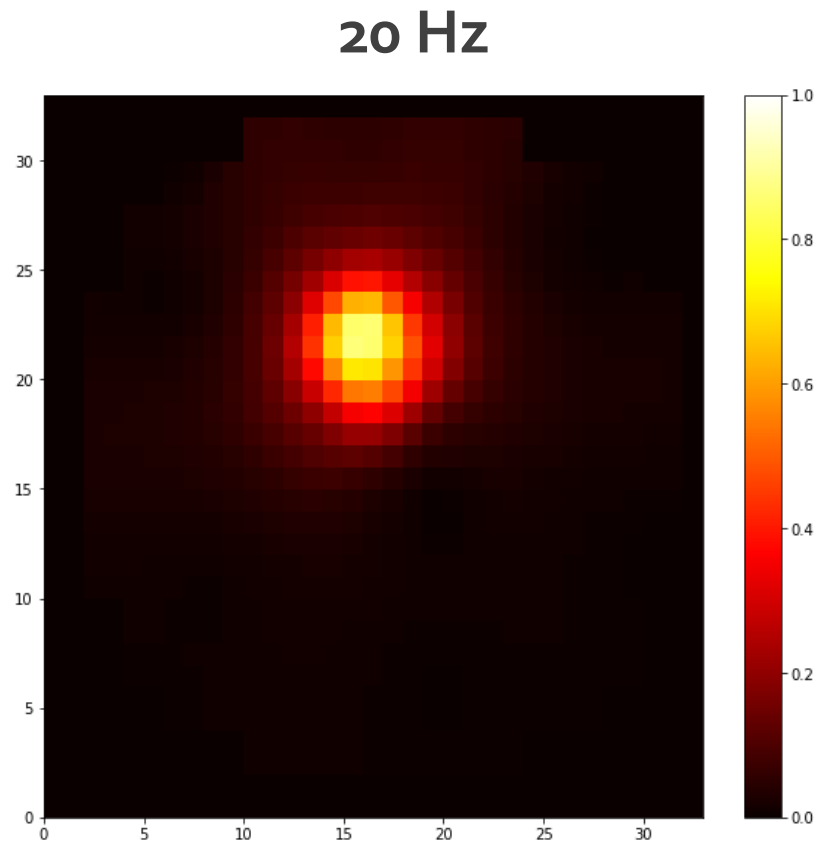
Results: Axially Traveling Perturbations



Results: Fuel Assembly Vibrations (cantilevered beam mode)



Results: Absorber of Variable Strength (axial level 9)



Thank you! Any questions?

