RUTGERS
WINLAB | Wireless Information Network Laboratory

Machine-Induced Noise Mitigation

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Background

NextGen manufacturing environments require extensive use of wireless communication systems to automate processes like assembly lines, however such environments create two major challenges: impulsive noise and multipath fading.

- **Impulsive Noise (IN):** Generated by machines, significant high power spikes that are very inconsistent
- **Multipath Fading (MF):** Produced by objects in environment, signal reflections off surfaces, particularly metals, that also get caught at the receiver

Both introduce ways in which the intended signal gets scrambled and becomes harder to demodulate or decode back to the original information.

Objectives

- Measure and characterize the impacts of IN on existing systems
- Model and synthesize IN for injection to the OFDM reception chain
- Evaluate and mitigate the impact of IN on OFDM Signals

What is OFDM & Why Use It?

- **Orthogonal Frequency Division Multiplexing** is a modulation technique (Fig 1)
- Used in existing systems like WiFi, 4G LTE, 5G, etc.
- Built-in resistance to ISI, Inter-Symbol Interference, presented by **MF**.
  - Guard intervals protect against MF by prepending the end of an OFDM frame.

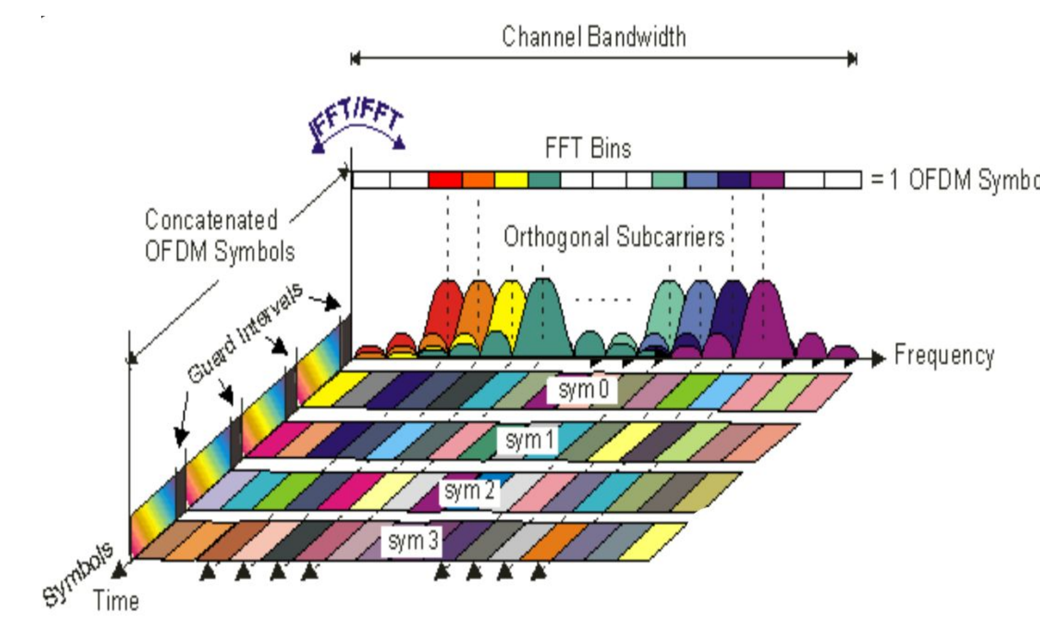

Fig 1: Visualization of OFDM Frame Construction

Noise Model Synthesis

Power Spectral Density (PSD) of Measured Noise
Fig 2

→ Gaussian Mixture Model (GMM)
Fig 3

→ Computing Threshold

→ Hidden Markov Model (HMM)

→ Synthesized Noise Model (SN)
Fig 4

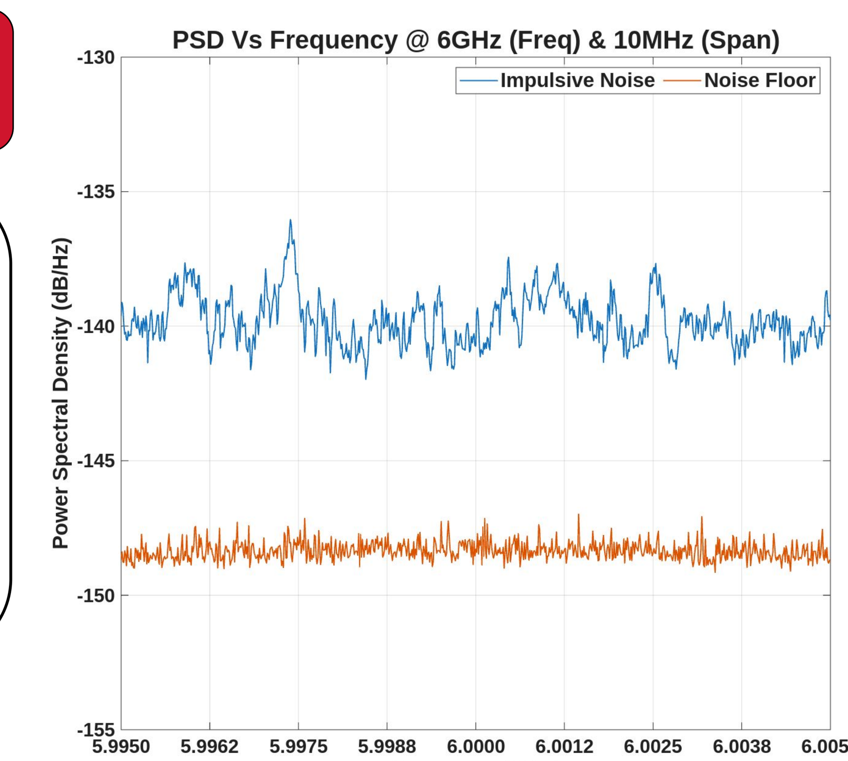

Fig 2: PSD of Noisefloor & Measured IN

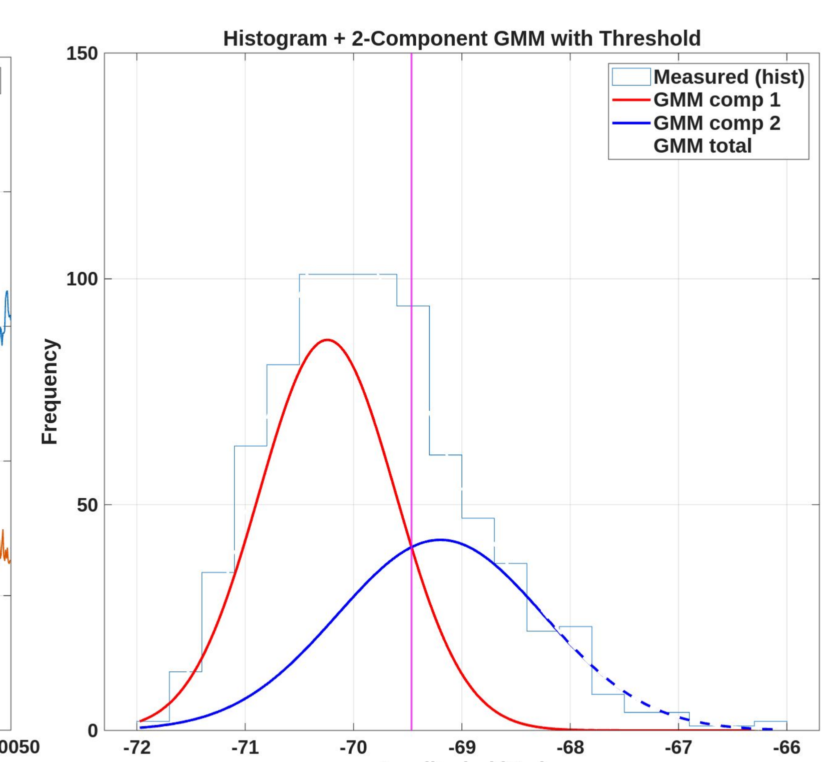

Fig 3: GMM

Emulating OFDM in FR3

- Injected SN into a high Signal-to-Noise Ratio **(SNR)**, low Bit Error Rate **(BER)** capture.
- Plotted results of both **IN** and Added White Gaussian Noise **(AWGN**, more predictable noise). See Fig 5.
- As expected **AWGN** outperforms **IN**, demonstrating the effects of **IN**.

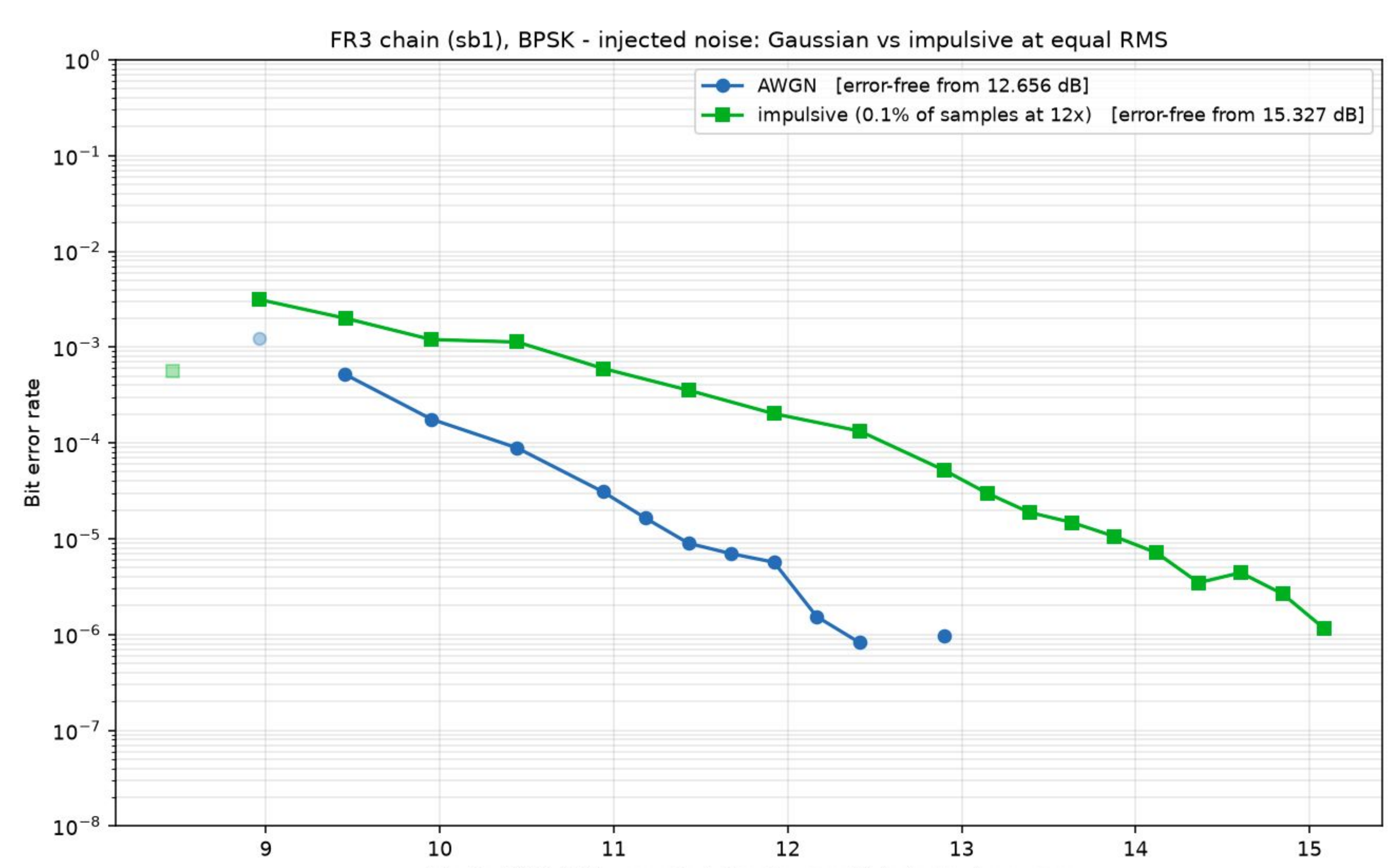

Fig 5: SNR-BER Curves, IN vs AWGN

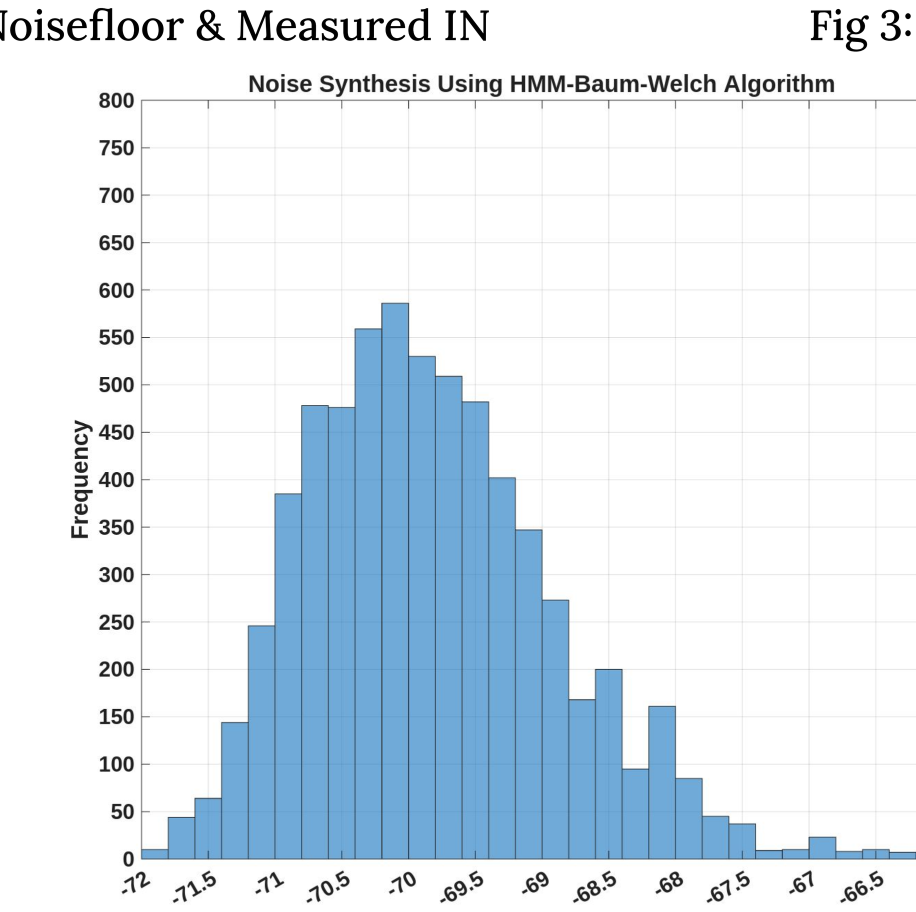

Fig 4: HMM for Histogram of SN

Future Work

- Deploying various mitigation strategies and evaluating them against one another
  - RSC, LDPC, Polar Codes, etc.

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