

Noise calibration, delay coherence and SNR walls for signal detection

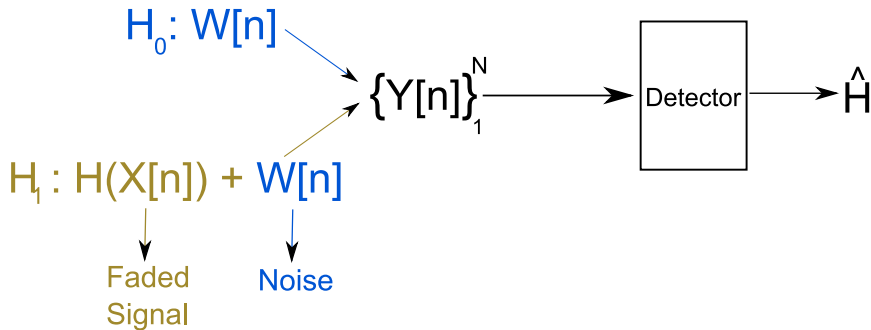
Rahul Tandra Anant Sahai

Wireless Foundations Center
Department of Electrical Engineering and Computer Sciences
University of California, Berkeley

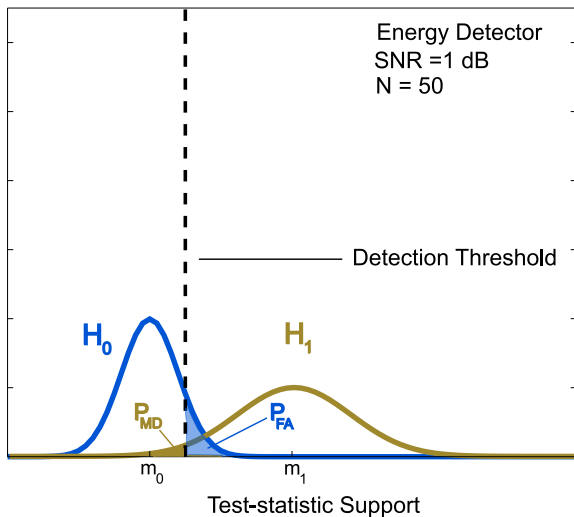
15th October, DySpAN 2008

The logo for the Wireless Foundations Center, featuring a blue and white circular graphic with concentric lines, and the text "Wireless Foundations" in a stylized font.

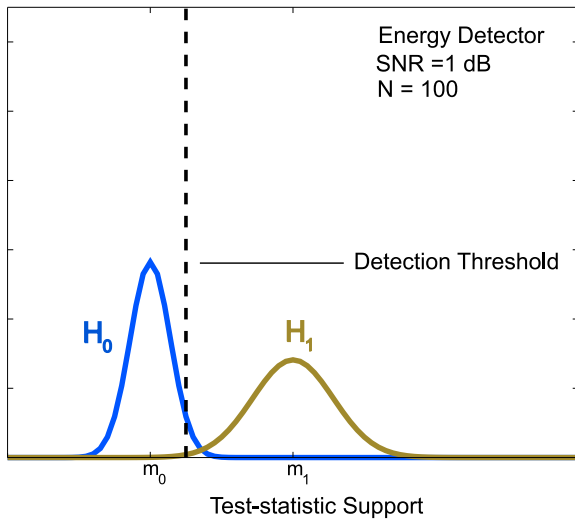
Problem setup



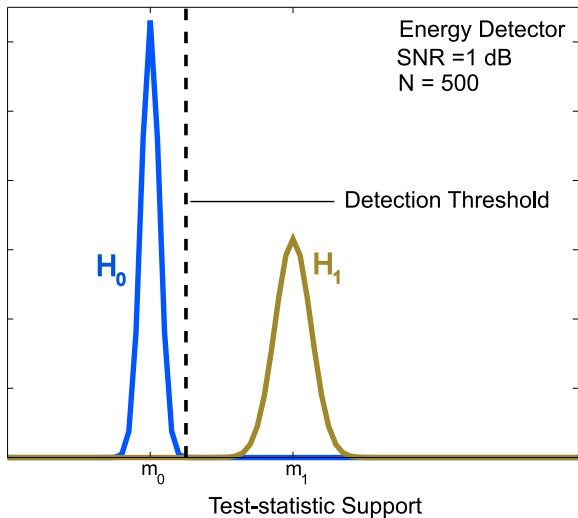
Spectrum sensing: traditional picture



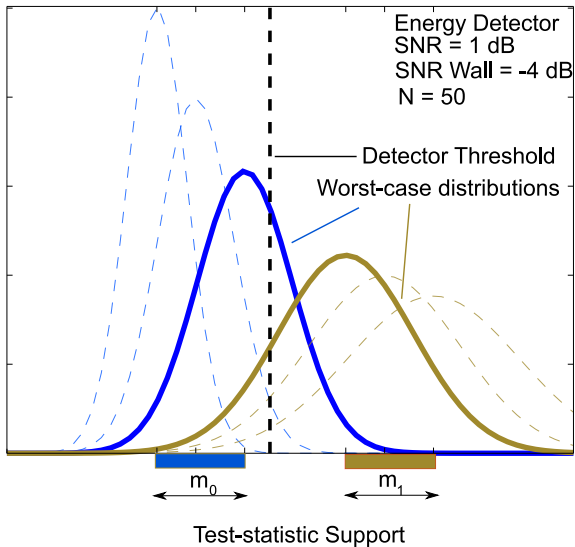
Spectrum sensing: traditional picture



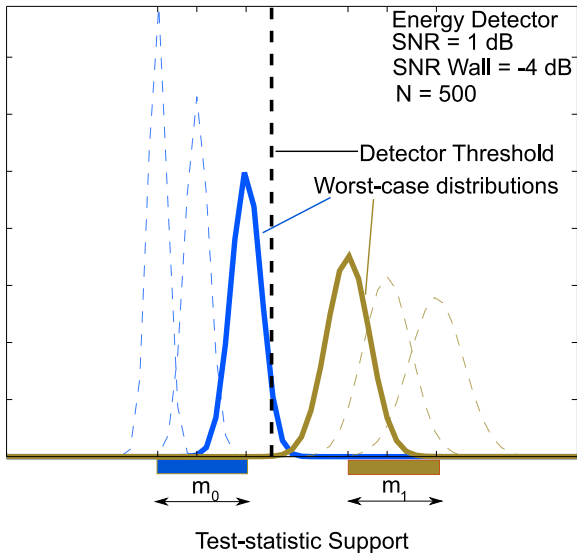
Spectrum sensing: traditional picture



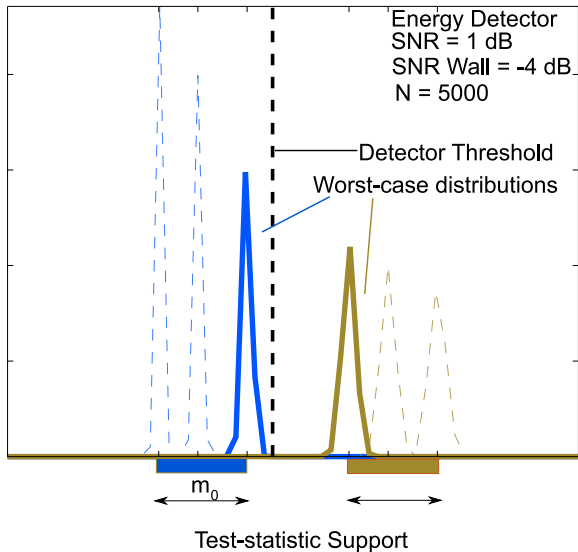
Spectrum sensing: noise uncertainty



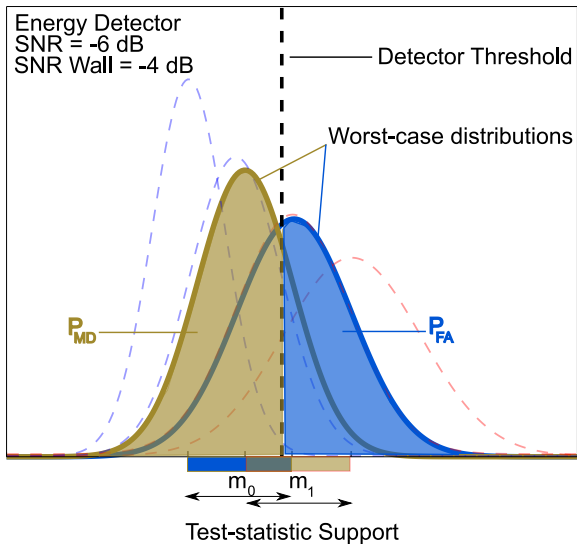
Spectrum sensing: noise uncertainty



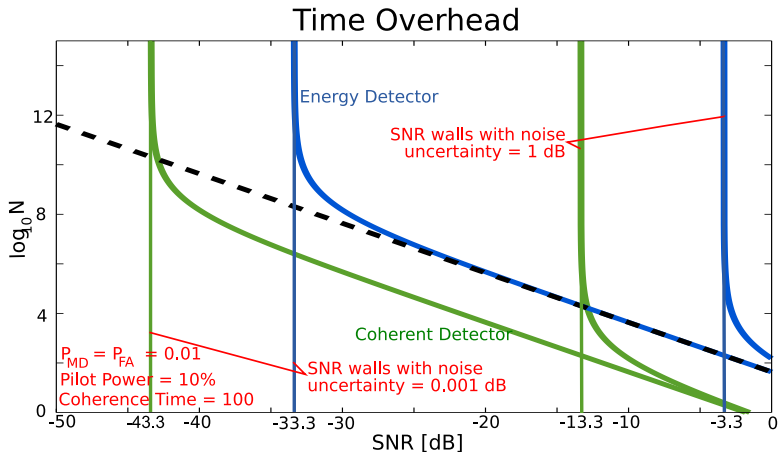
Spectrum sensing: noise uncertainty



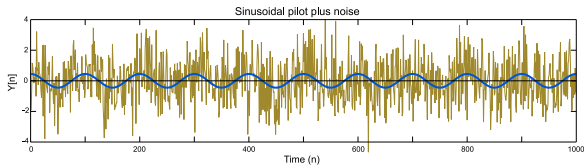
Spectrum sensing: SNR walls



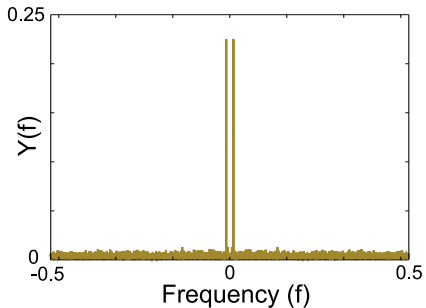
Impact of SNR walls — sensing overhead



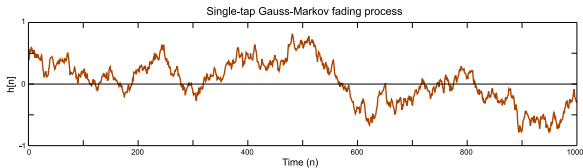
Narrowband pilot signals



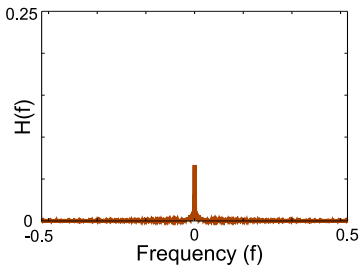
Magnitude response of sinusoidal pilot plus noise



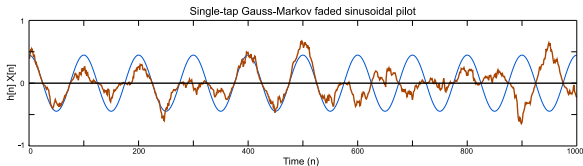
Narrowband pilot signals



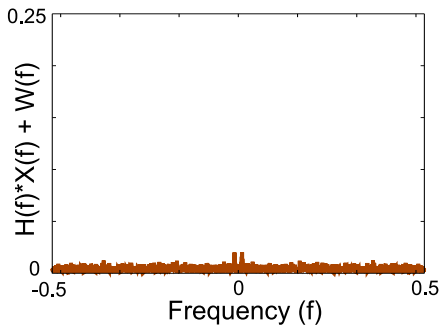
Magnitude response of a single-tap Gauss-Markov process



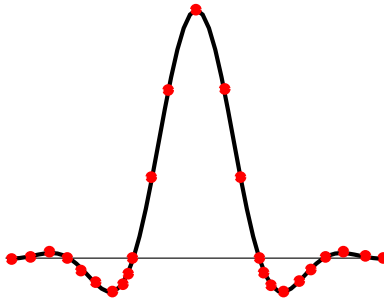
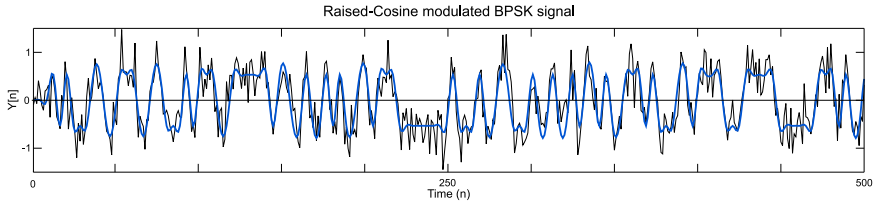
Narrowband pilot signals



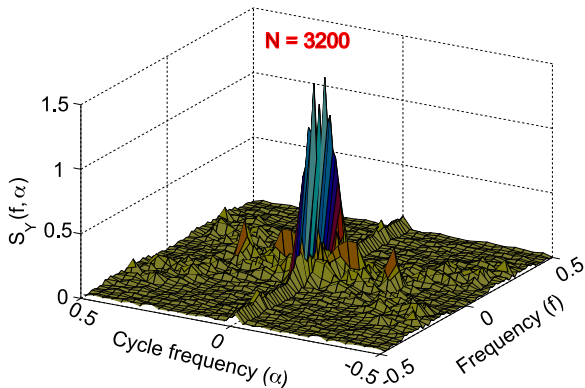
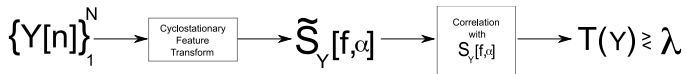
Magnitude response of faded pilot plus noise



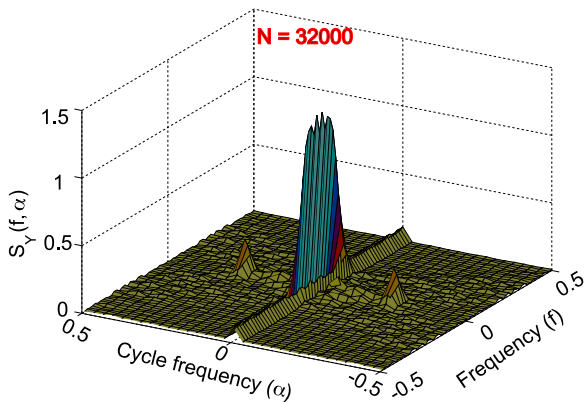
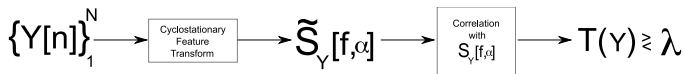
Cyclostationary signals



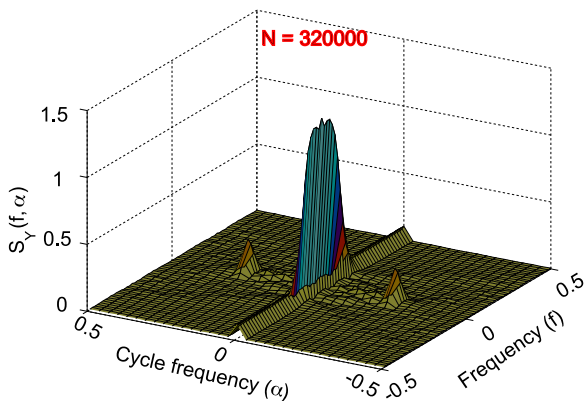
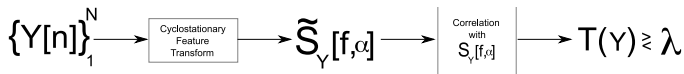
Cyclostationary feature detection



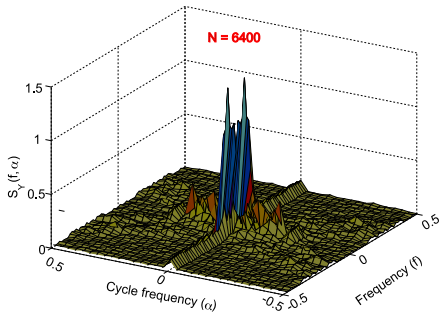
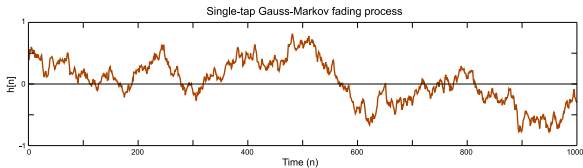
Cyclostationary feature detection



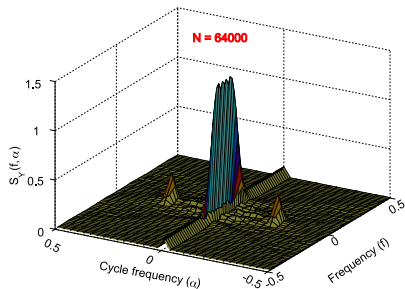
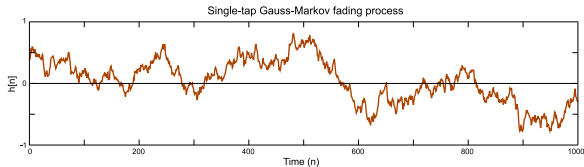
Cyclostationary feature detection



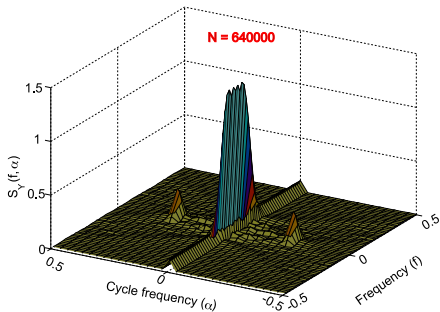
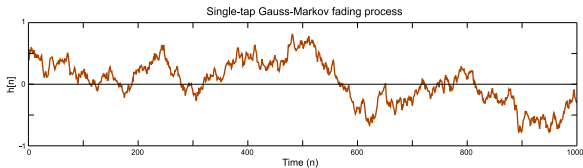
Feature detection: single-tap Gauss-Markov fading



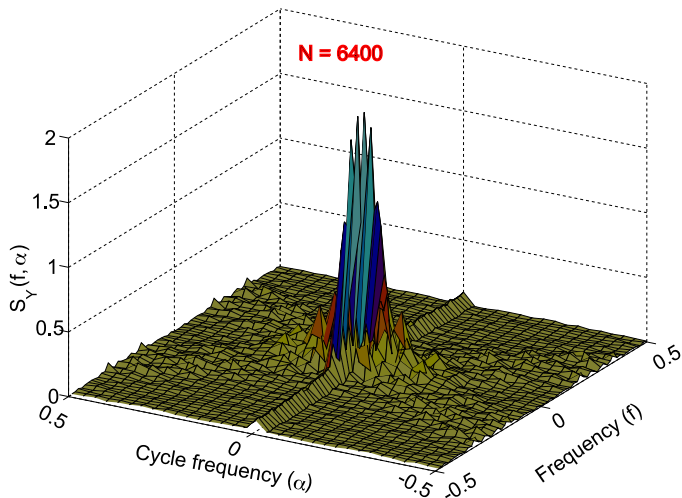
Feature detection: single-tap Gauss-Markov fading



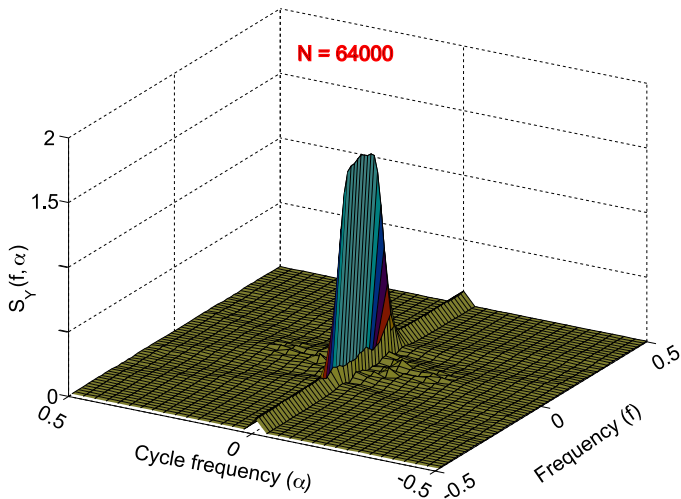
Feature detection: single-tap Gauss-Markov fading



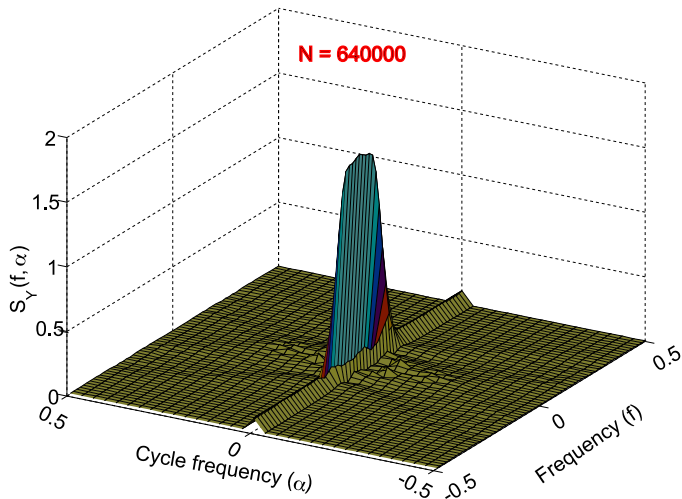
Feature detection: multi-tap Gauss-Markov fading



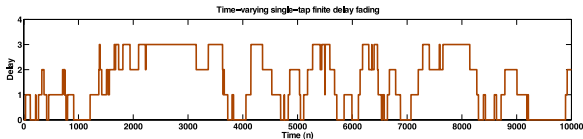
Feature detection: multi-tap Gauss-Markov fading



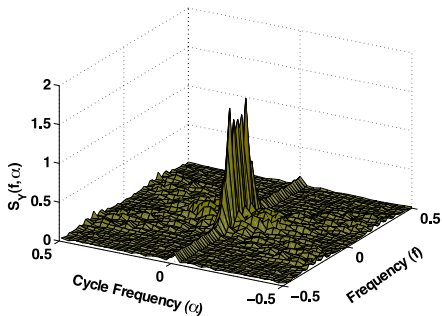
Feature detection: multi-tap Gauss-Markov fading



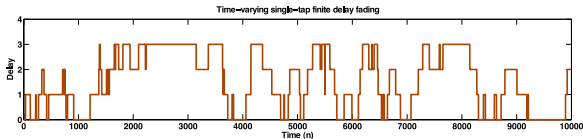
Feature detection: finite-delay fading process



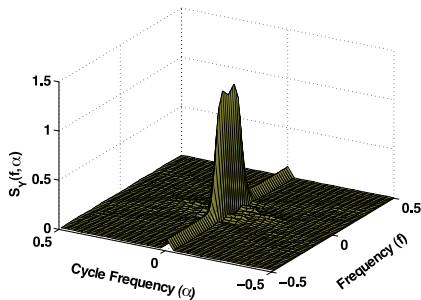
Single-tap time-varying finite delay fading, $N = 3200$



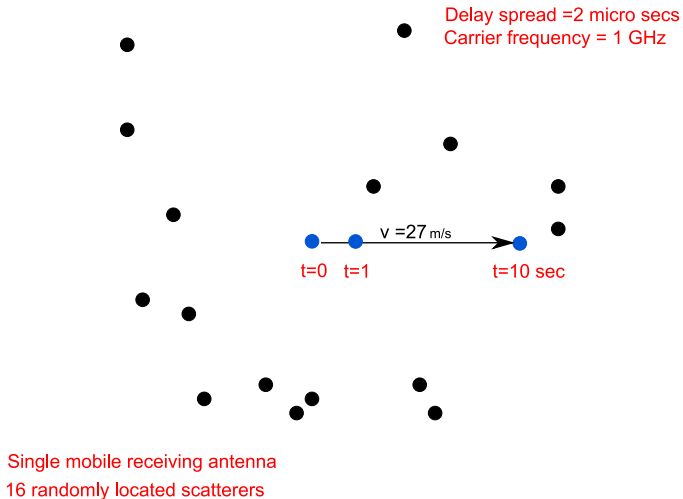
Feature detection: finite-delay fading process



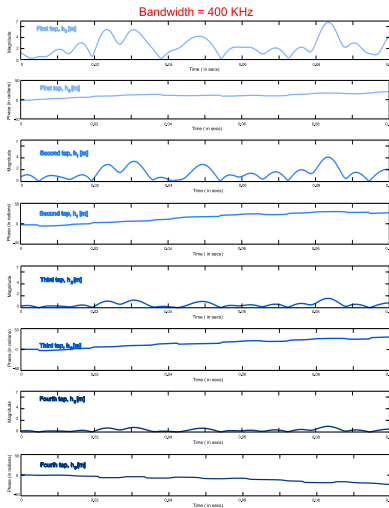
Single-tap time-varying finite delay fading, $N=320000$



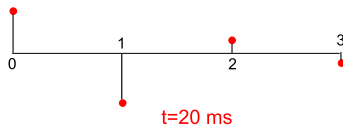
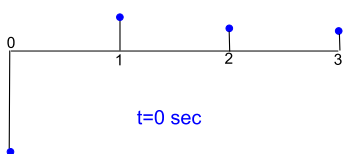
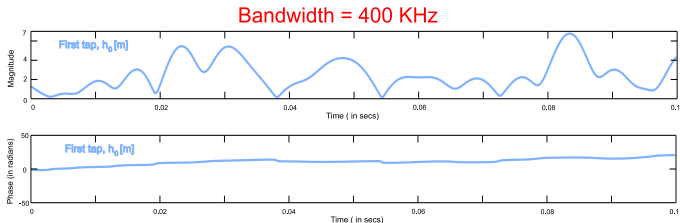
Phase coherence vs Delay coherence



Phase coherence vs Delay coherence

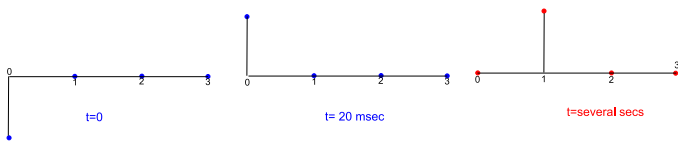
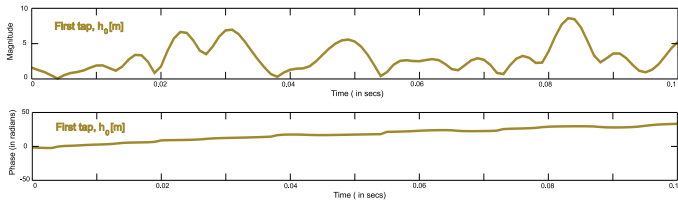


Phase coherence vs Delay coherence

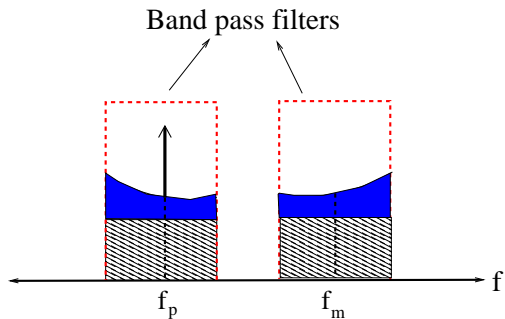
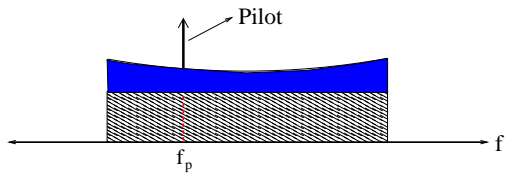


Phase coherence vs Delay coherence

Bandwidth = 1 KHz



Noise calibration: pilot case



Noise calibration: cyclostationary feature detection



AGC calibration:

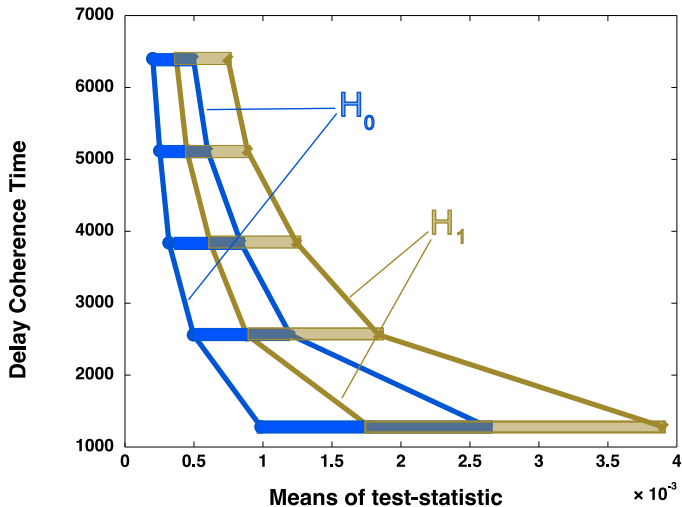
$$\hat{Y}[n] = \frac{1}{\sqrt{\frac{1}{N} \sum_{n=1}^N |Y[n]|^2}} Y[n]$$

As $N \rightarrow \infty$

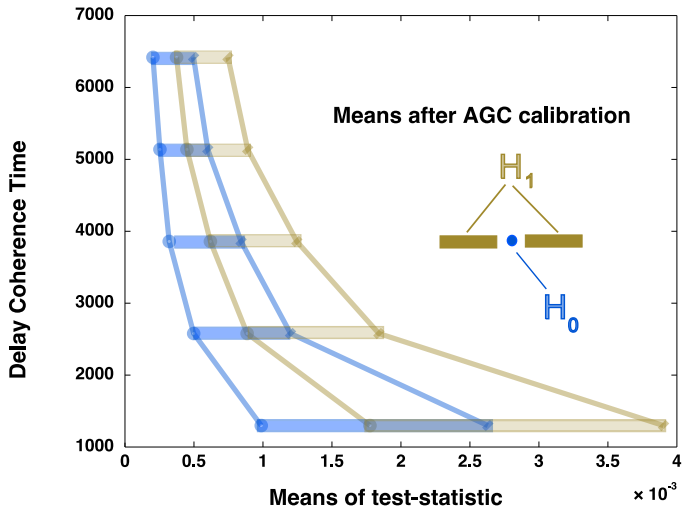
$$\frac{1}{\sqrt{\frac{1}{N} \sum_{n=1}^N |Y[n]|^2}} \rightarrow \begin{cases} \frac{1}{\sigma_a} & \text{Under } \mathcal{H}_0 \\ \frac{1}{\sqrt{P + \sigma_a^2}} & \text{Under } \mathcal{H}_1 \end{cases}$$



Robustness gains from noise calibration



Robustness gains from noise calibration



Robustness gains from noise calibration

Colored noise model:

$$W[n] = M[n] - \beta M[n - 1],$$

$M[n]$ is *iid* white Gaussian noise, $\beta \in [0, \beta_{max}]$.

