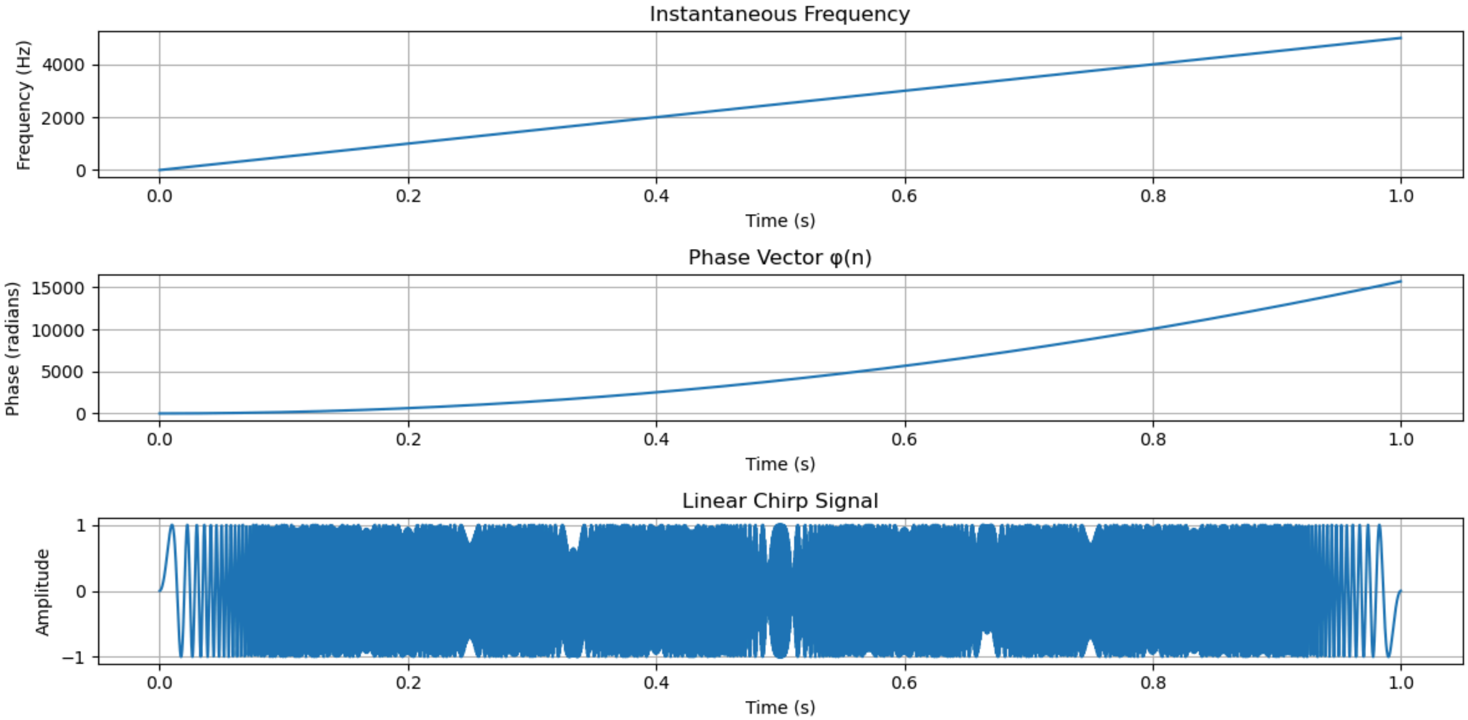
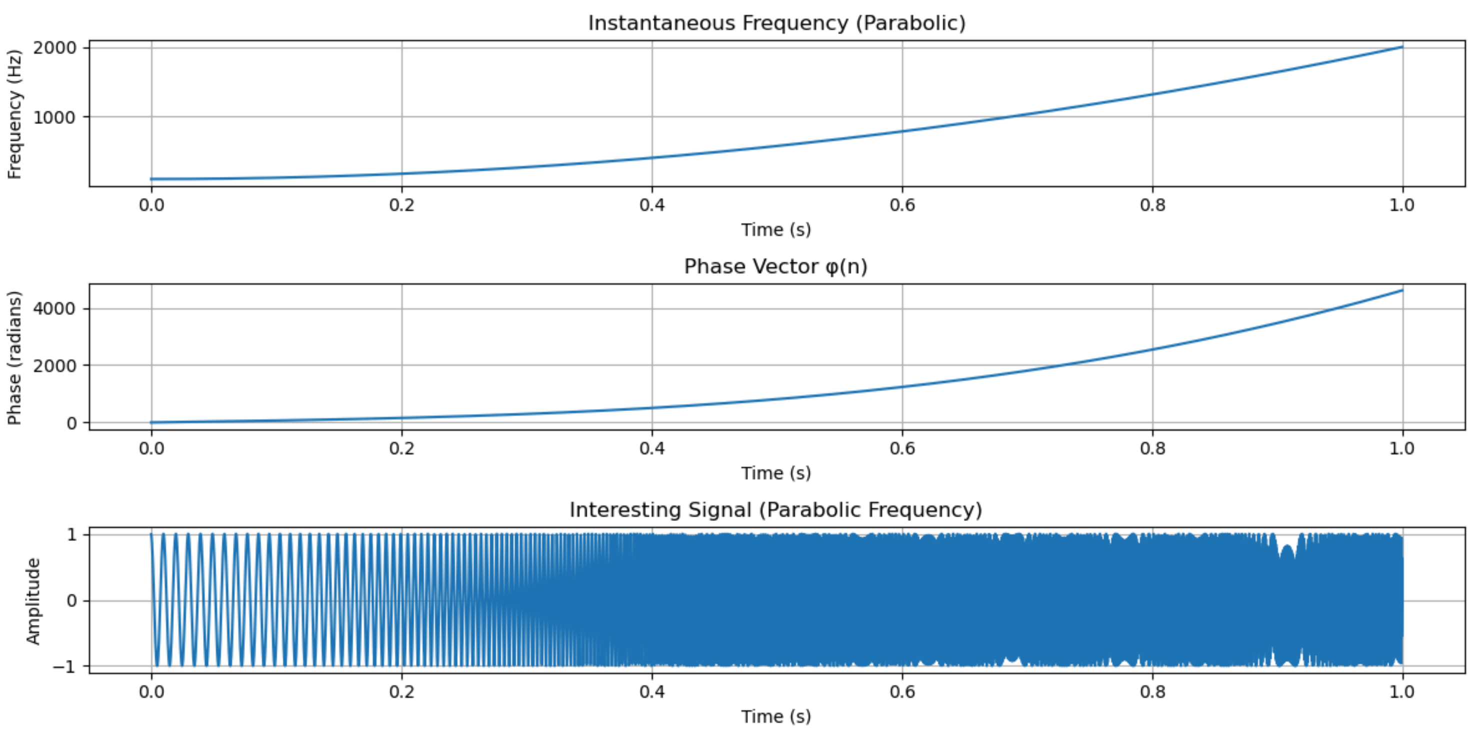
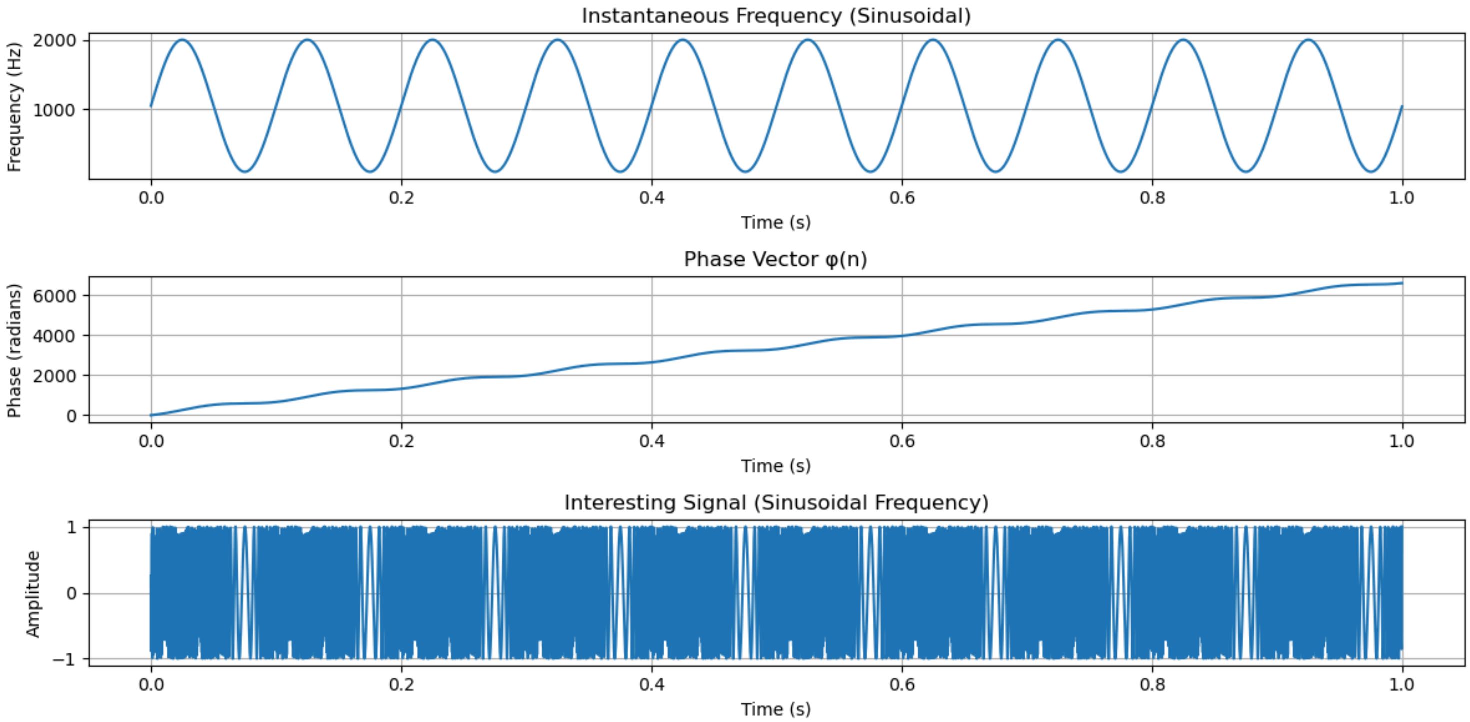
1.1.1 Signal 1: Linear Chirp

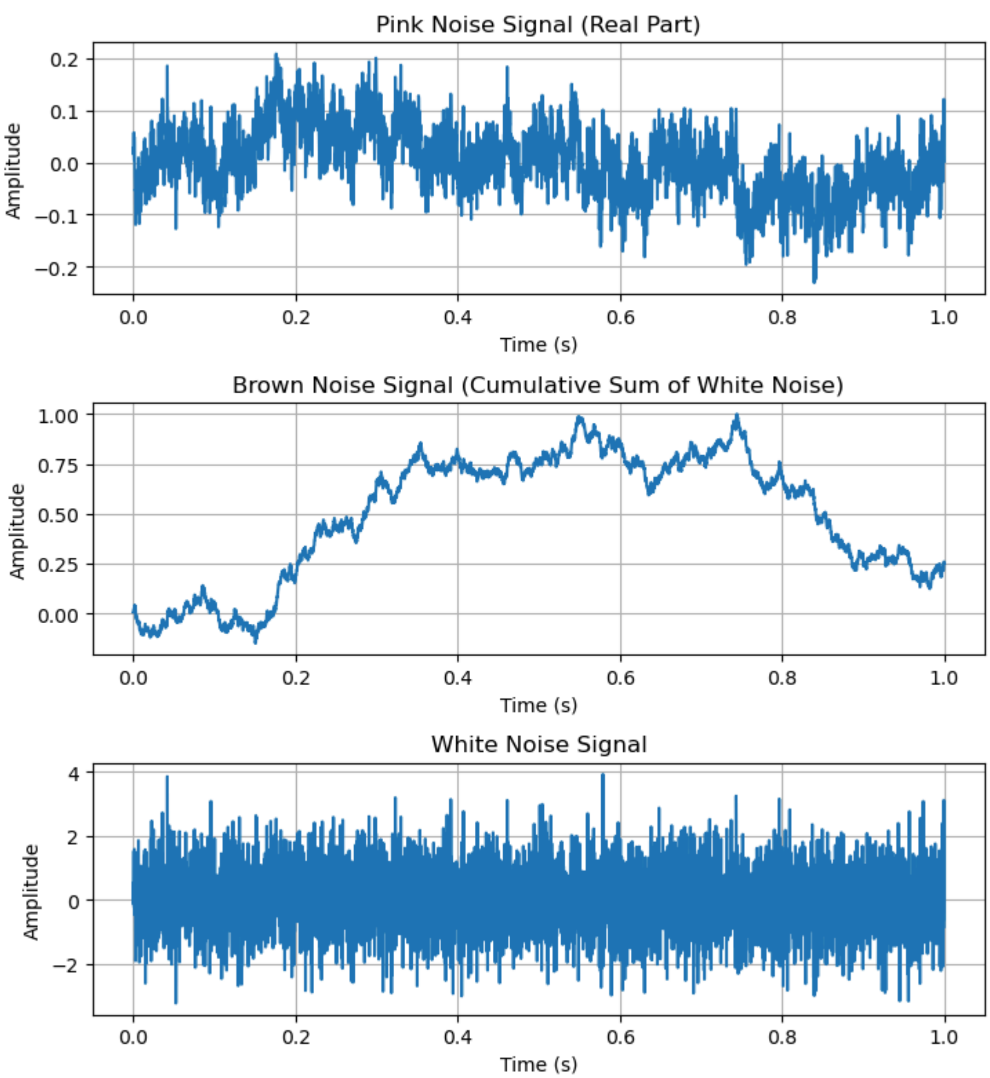


1.1.2 Signal 2: “Interesting” Signal

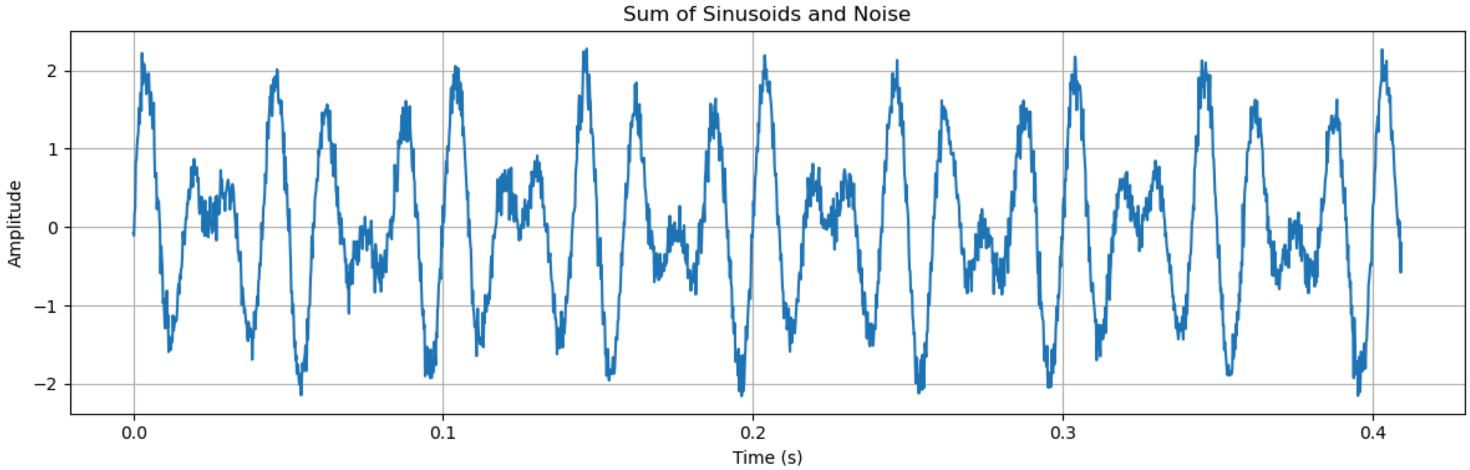




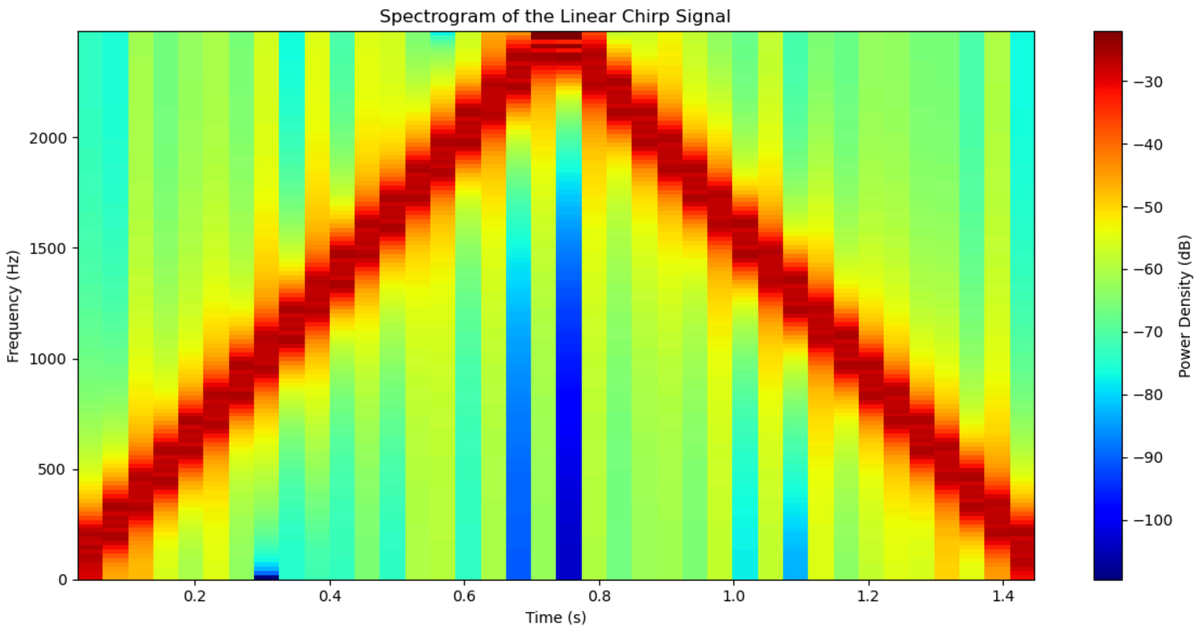
1.2 Power-Law Noises



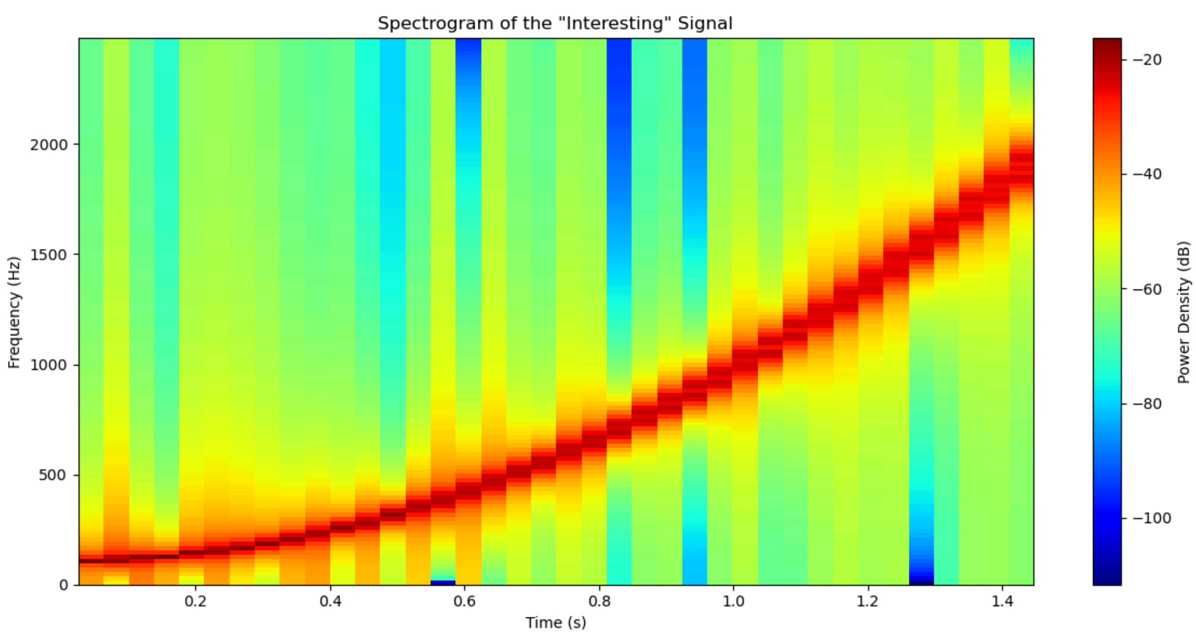
1.3 Simulated Recording: Three Sinusoids in white noise



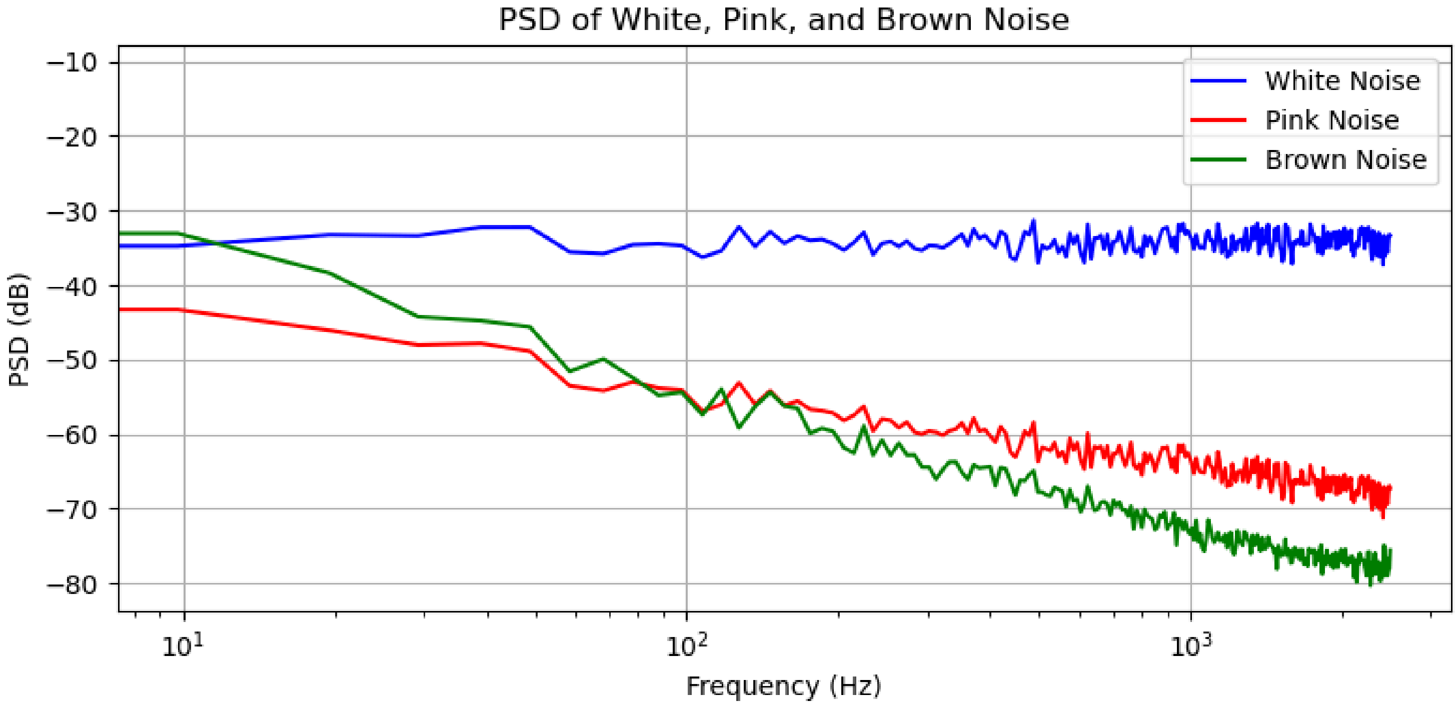
2.1 Spectrogram of Signal 1: Linear Chirp



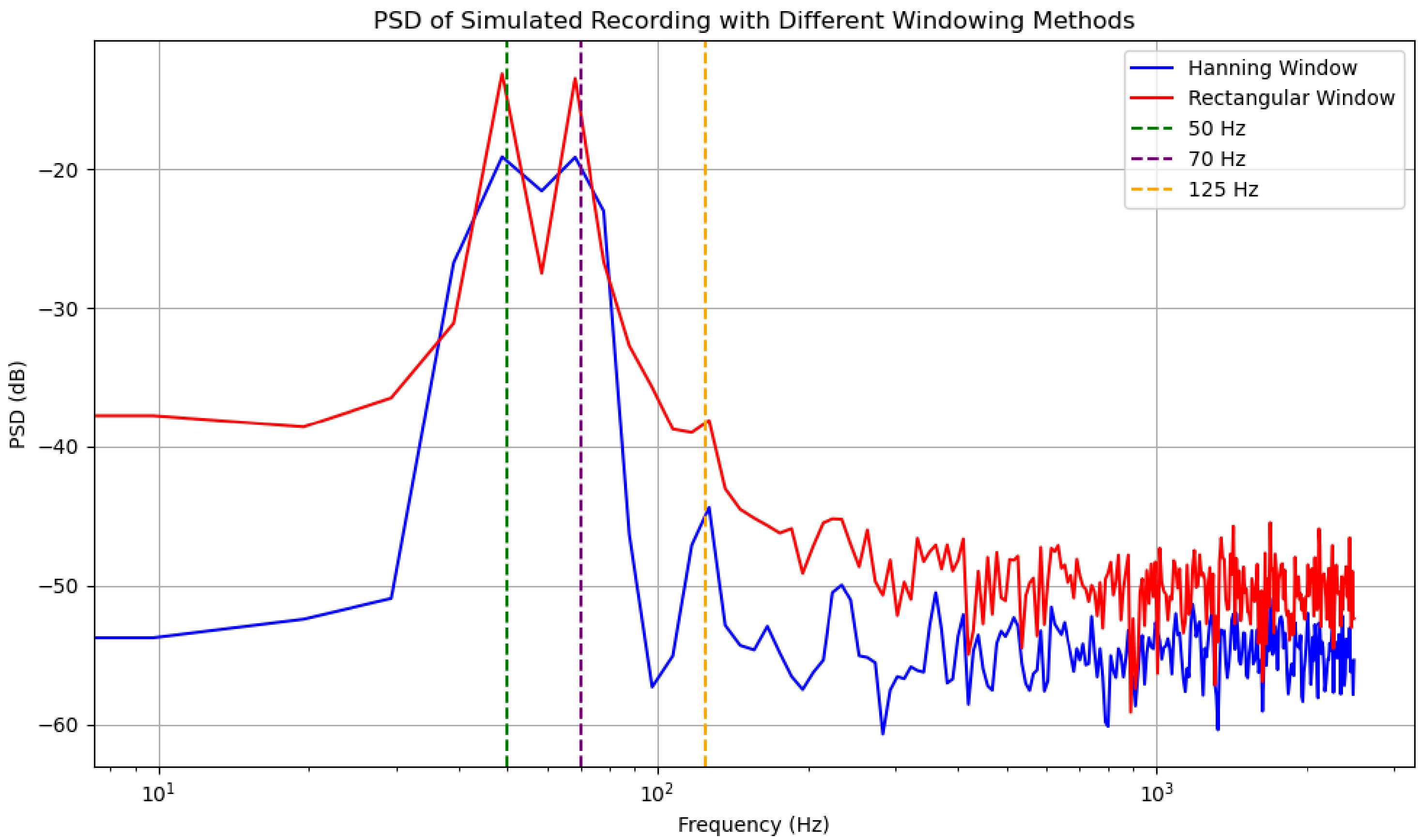
2.2 Spectrogram of Signal 2: “Interesting” Signal



2.3 Power Spectra of Power-Law Noises



2.4 Analysis of Simulated Recording



3 Questions

1. The triangular shape and deviation in the second half of the spectrogram is due to aliasing caused by the insufficient sampling rate. The sampling rate of 5000 Hz is only just enough to represent frequencies up to 2500 Hz correctly, and anything above that causes the higher frequencies to fold back, resulting in the observed distortion. To resolve this, you should increase the sampling rate to at least 10 kHz, or apply an anti-aliasing filter before sampling.

2. When using the Hanning window compared to using a rectangular window, it results in less spectral leakage, which explains the relative magnitude of the 125 Hz compared to its immediate neighbourhood. However, using the Hanning window also results in a decrease in frequency resolution, which is why the peaks of the 50 Hz and 75 Hz components are much less differentiated.

1

$$E_{\text{ion}} = \frac{61}{z}\log\frac{[\text{ion}]_{\text{out}}}{[\text{ion}]_{\text{in}}}$$

Table 1: External and internal concentrations of several ions in human cells

	Ion	Ext Conc (mM)	Int Conc (mM)	Ratio Ext:In
	K^+	5	100	1 : 20
	Na^+	150	15	10 : 1
3	Ca^{2+}	2	0.0002	10000 : 1
2	Cl^-	150	13	11.5 : 1

3. Cl^-:

$$E_{Cl^-} = \frac{61}{z_{Cl^-}}\log\frac{[Cl^-]_{out}}{[Cl^-]_{in}} = \frac{61}{-1}\log\frac{(150)}{(13)} = \boxed{-64.79\ mV}$$

Ca^{2+}:

$$E_{Ca^{2+}} = \frac{61}{z_{Ca^{2+}}}\log\frac{[Ca^{2+}]_{out}}{[Ca^{2+}]_{in}} = \frac{61}{2}\log\frac{(2)}{(0.0002)} = \boxed{122\ mV}$$