Digital Signal Processing (EE313): Spectral analysis with DFT

Krishnan C.M.C

Assistant Professor, E&E,

NITK Surathkal

Spectral leakage

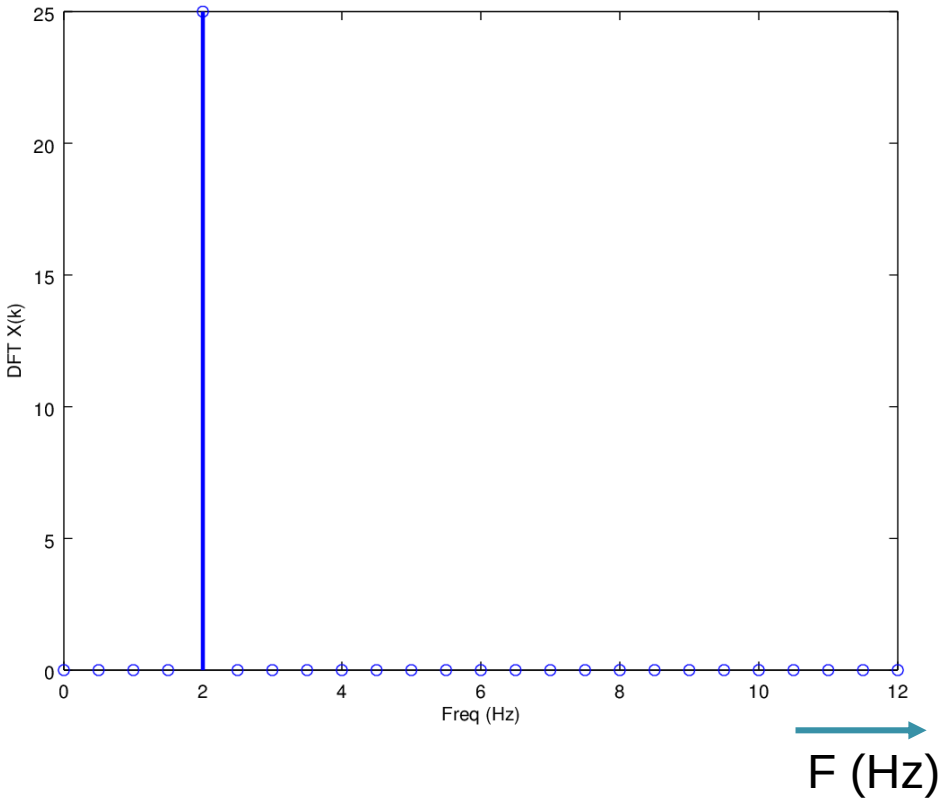
$x_a(t) = \sin(4\pi t)$

$0 \leq n \leq 49$ or $N = 50$

$Fs = 25$

$t_{max} = 2 - \frac{1}{Fs}$

$\frac{k}{N} = \frac{F}{F_s}$

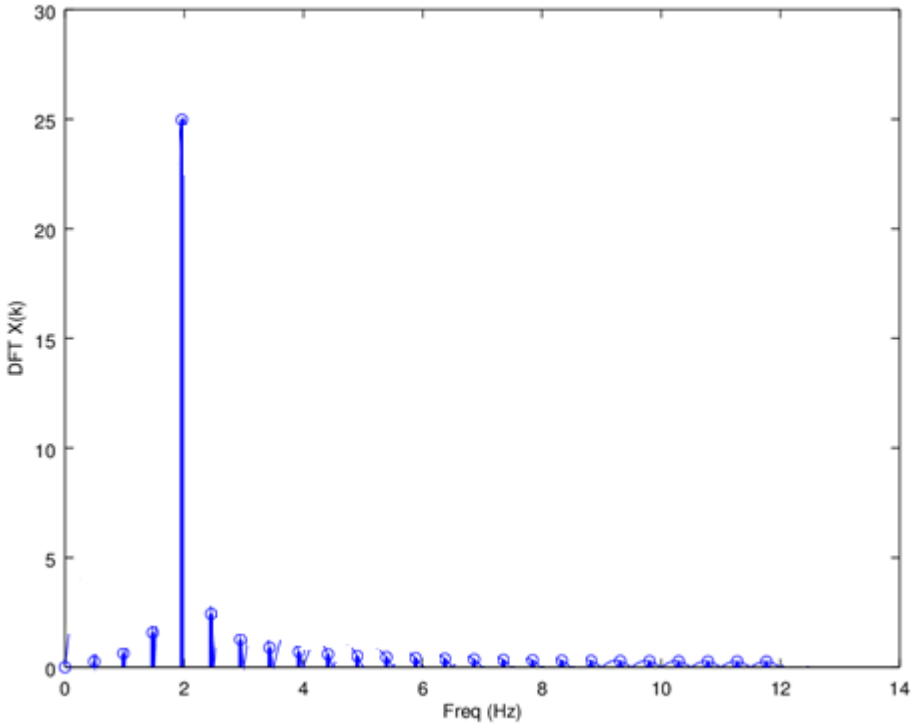


Spectral leakage

$x_a(t) = \sin(4\pi t)$

$0 \leq n \leq 50$ or $N = 51$

$Fs = 25$

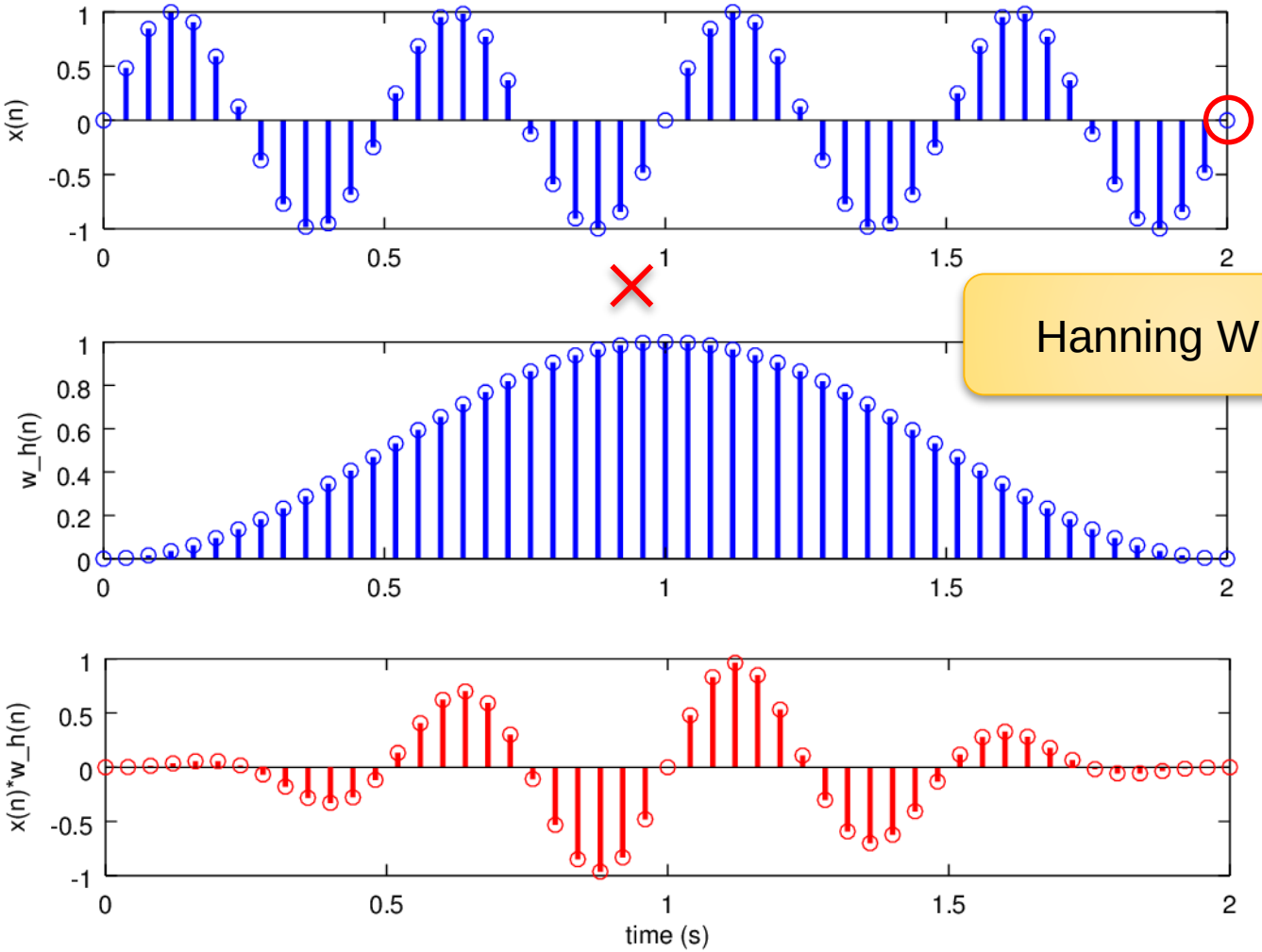


$$\frac{k}{N} = \frac{F}{F_s}$$

$$k = 51 \times \frac{2}{25} = 4.08$$

$$\Rightarrow \boldsymbol{X(k) \neq 0 \; \forall k}$$

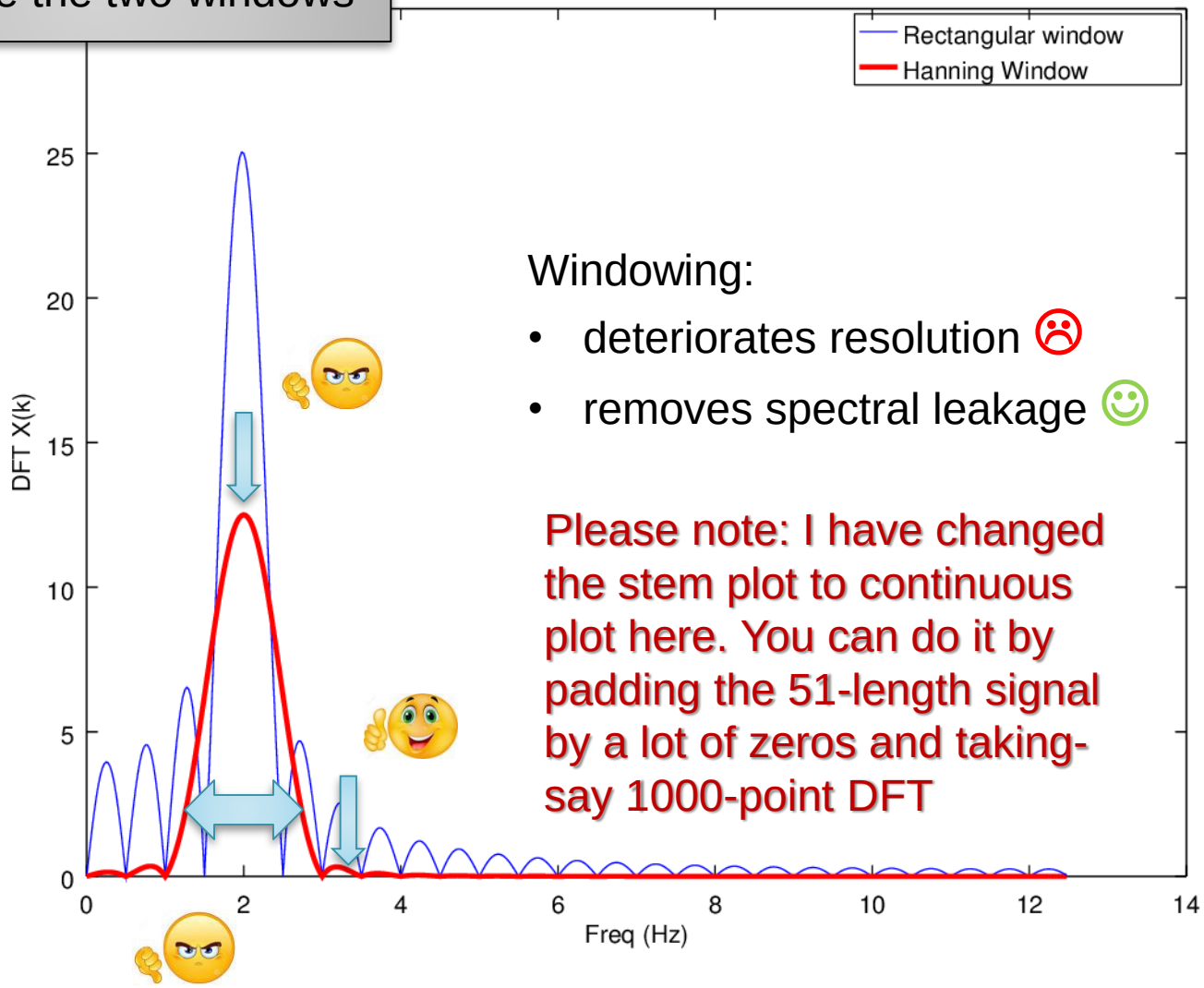
Spectral smoothing using time-domain windowing



Hanning Window

Spectral smoothing using time-domain windowing

Compare the two windows



Windowing:

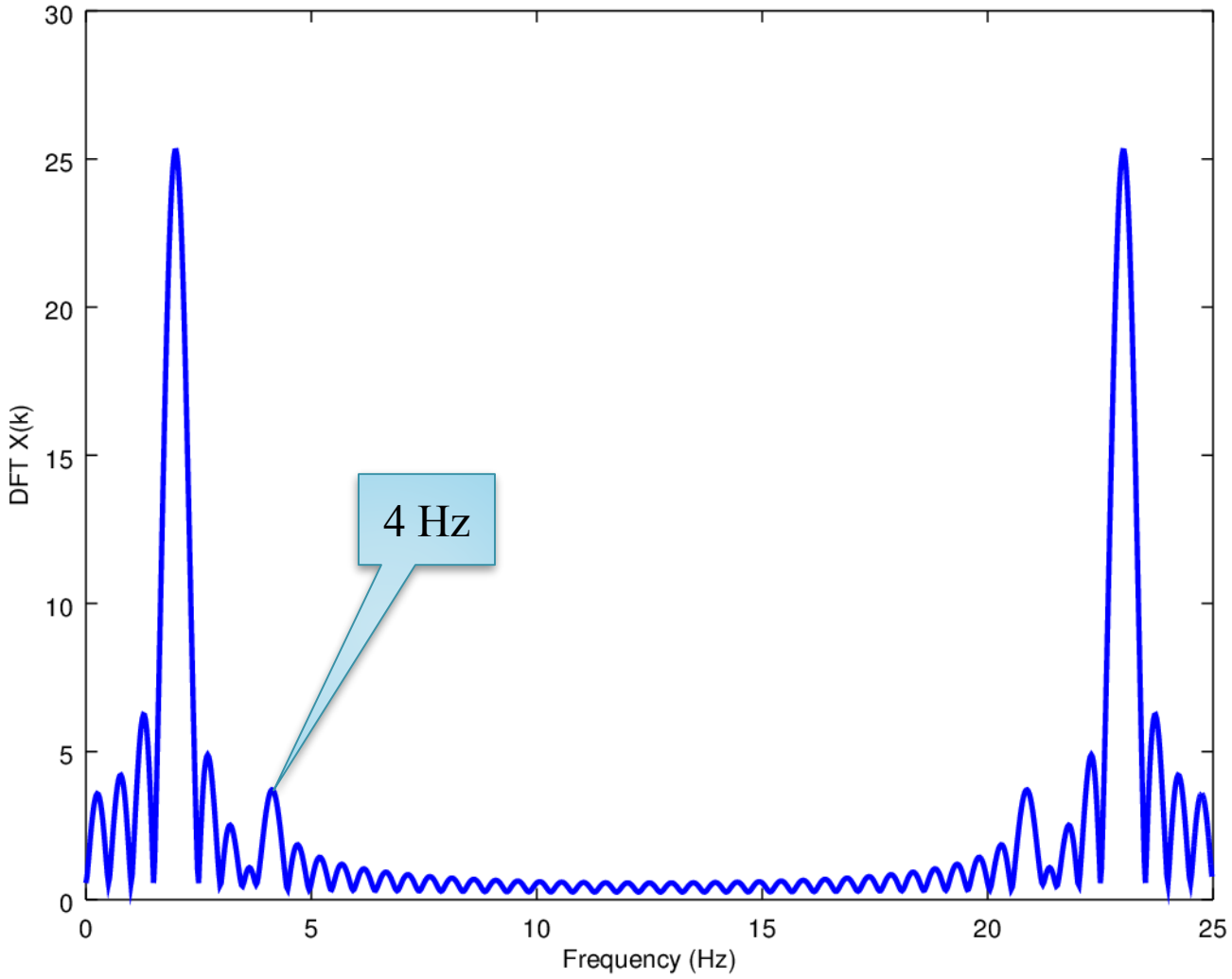
- deteriorates resolution ☹
- removes spectral leakage ☺

Please note: I have changed the stem plot to continuous plot here. You can do it by padding the 51-length signal by a lot of zeros and taking- say 1000-point DFT

Spectral smoothing using time-domain windowing

$x_a(t) = \sin(4\pi t) + 0.1\sin(8\pi t)$

$Fs = 25, N = 52$



Spectral smoothing using time-domain windowing

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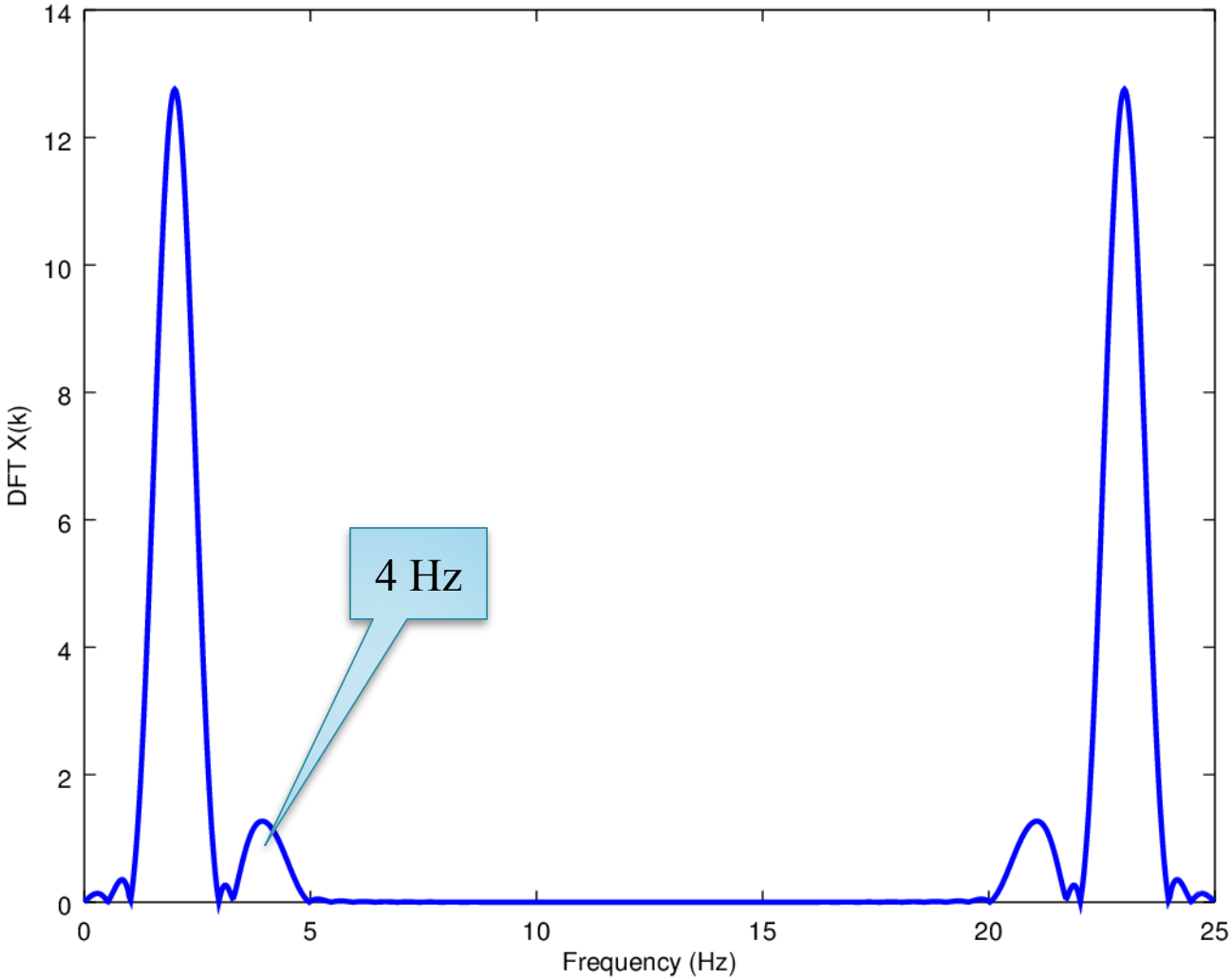
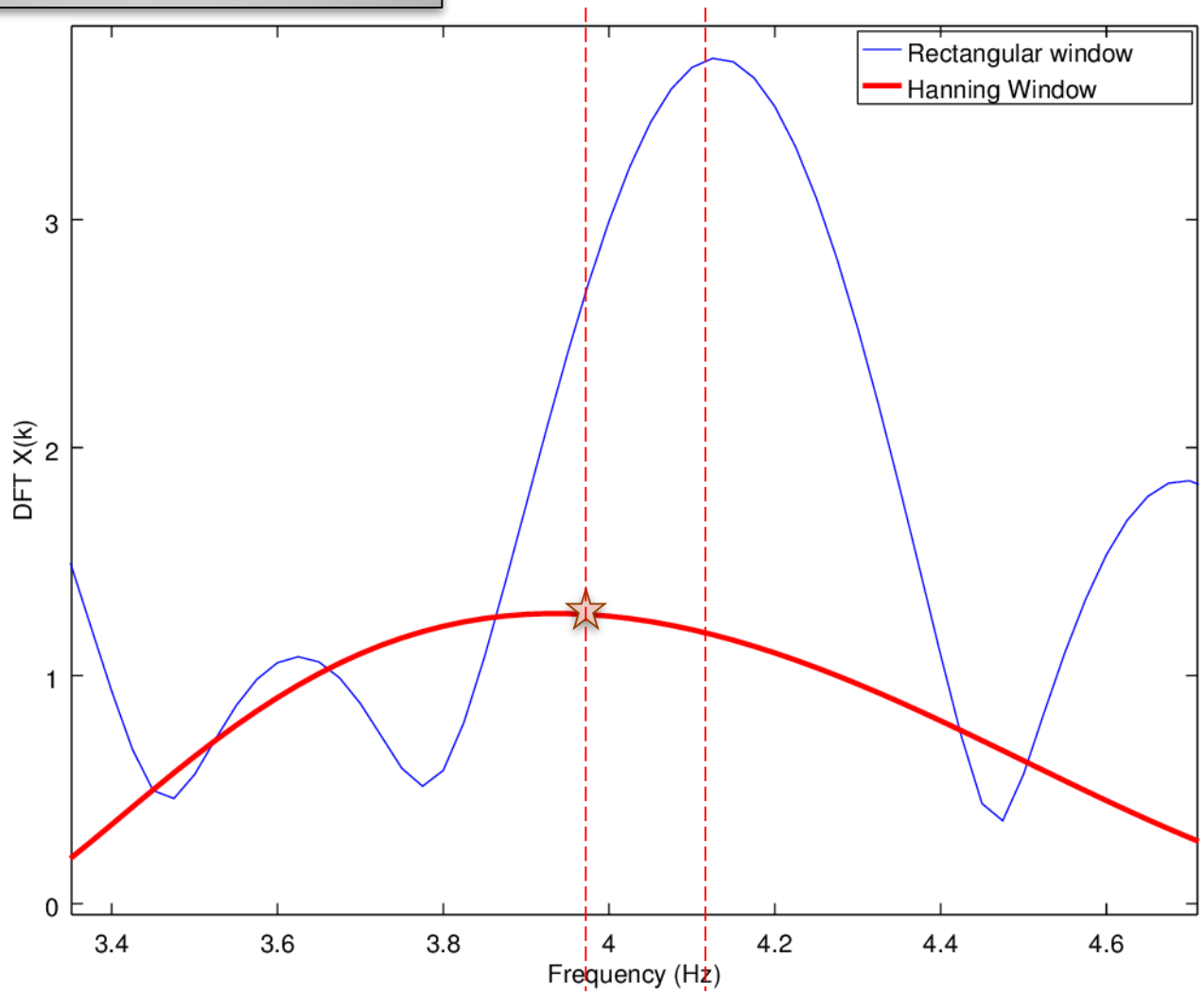
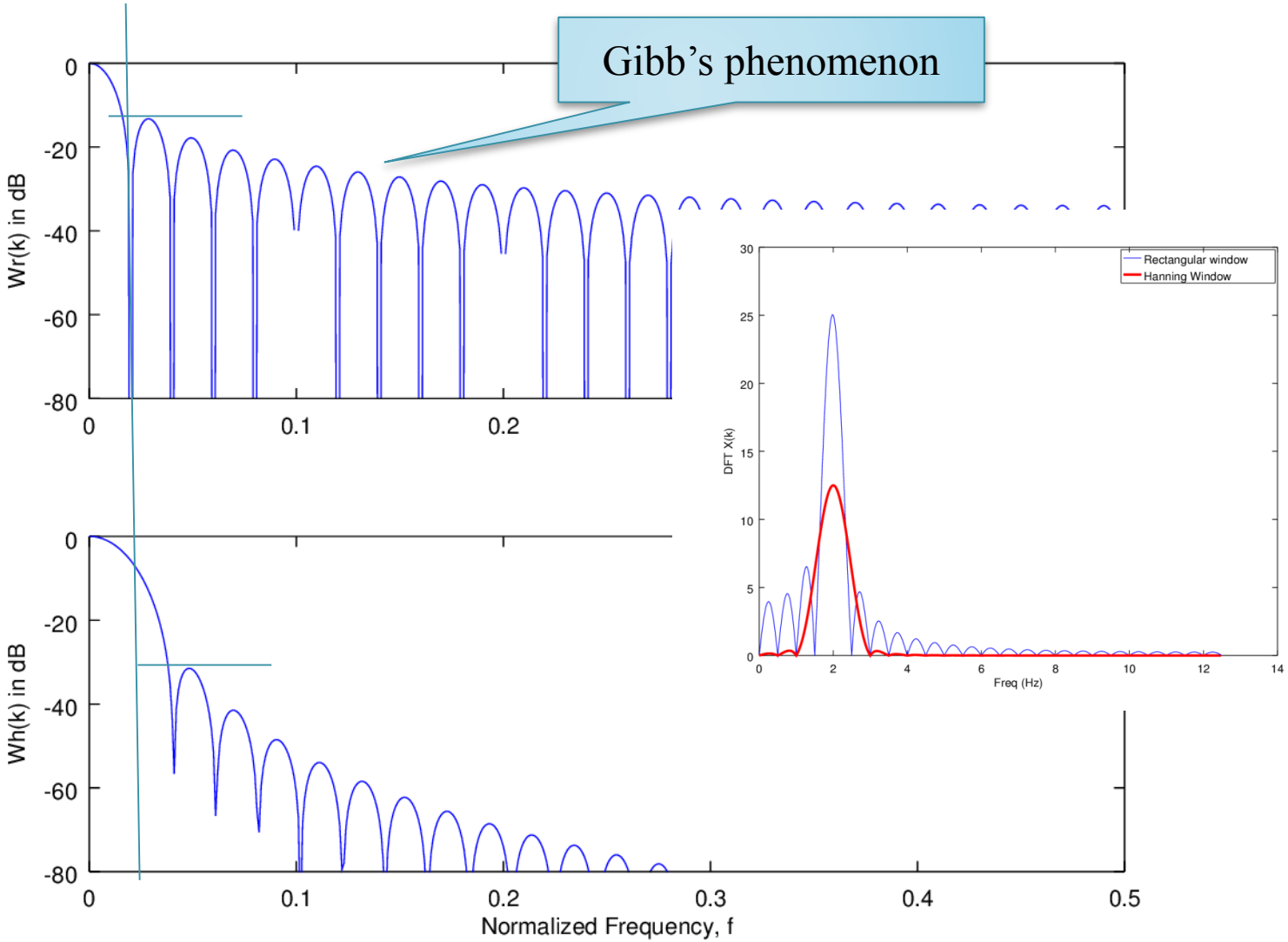


Spectral smoothing using time-domain windowing

Compare the two windows

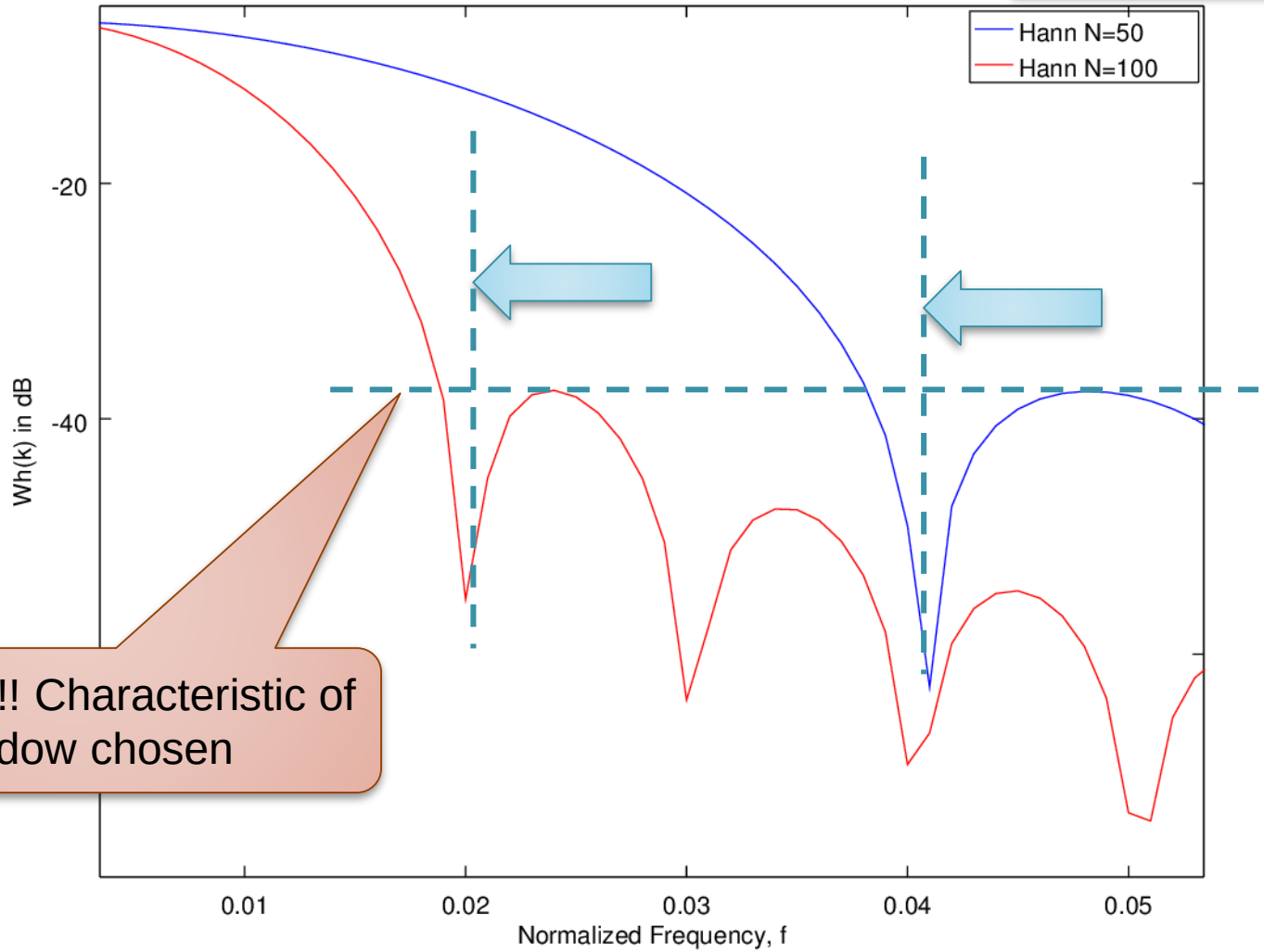


Different time-domain windows



Different time-domain windows

Increase the observation length (Hanning window)



No change!!! Characteristic of a window chosen