OFDM TX Shaping for 802.3bn

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Recommendations

- TX window is specified as N_t samples in taper region
  - No need for different set of Alpha for 4K and 8K FFT.
  - Avoid confusion for calculation of N_t with variable Cyclic Prefix.
    Alpha = N_t/N_{fft}, $T_p = N_t/204.8e6$
- N_t = {0, 32, 64, 128, 256}
  or T_p = {0, 0.15625, 0.3125, 0.625, 1.25} us
  - (Alpha = {0, 0.78125%, 1.5625%, 3.125%, 6.25% } for 4K FFT)
  - (Alpha = {0, 0.390625%, 0.78125%, 1.5625%, 3.125%} for 8K FFT)
- A postfix of N_t samples is added, windowing is applied to cyclic prefix and postfix
  - Windowing is absorbed by CP.
  - Symbol time is independent of Window N_t.
  - Receiver sampling is independent of TX window.
  - TX window appears to RX as post-cursor multipath, affect only the following symbol, not the previous symbol.

Windowing Function

Raised-Cosine Window

- Raised-Cosine window in frequency domain (FD):

$$\mathrm{P}(f) = \left[\frac{\sin(\pi f T)}{\pi f T}\left(\frac{\cos(\pi\alpha f T)}{1-(2\alpha f T)^2}\right)\right], \qquad 0 \le \alpha \le 1$$

- Raised-Cosine window in time domain (TD):

$$p(t) = \begin{cases} \frac{1}{T}, & 0 \le |t| < \frac{T(1-\alpha)}{2} \\ \frac{1}{2T}\left\{1+\cos\left[\frac{\pi}{\alpha T}\left(|t| - \frac{T(1-\alpha)}{2}\right)\right]\right\}, & \frac{T(1-\alpha)}{2} \le |t| \le \frac{T(1+\alpha)}{2} \\ 0, & \text{otherwise} \end{cases}$$

Note: α = 0 is a rectangular window (no shaping).

Examples of Raised-Cosine Window

MATLAB code for TX window p:

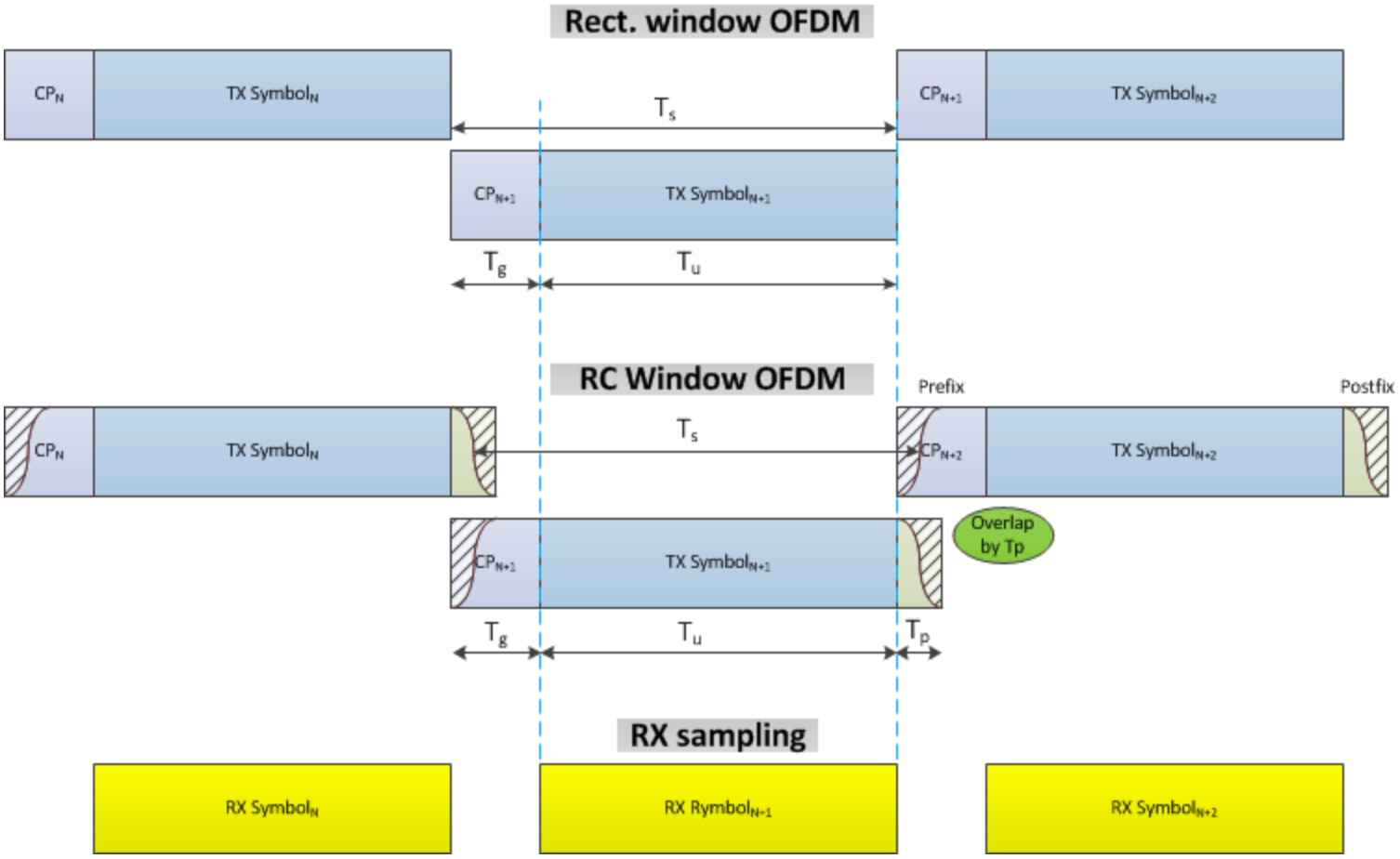
```
Nfft    = 4096;                                  % FFT size
CP      = 256;                                   % Nb. samples in Cyclic Prefix
Alpha   = 1/32;                                  % RX Alpha
Nt      = 2*round(Nfft*Alpha/2);                 % Nb. samples in taper region
p       = 1/2*(1+cos(pi*[-Nt+1/2:Nt-1/2]/Nt));   % Raised-Cosine in TD
p       = [p(1:Nt), ones(1,Nfft+CP-Nt), p(Nt+1:2*Nt)];   % Add ones in middle
```

Taper Region weight for Alpha = 1/128 (32 points):

0.0006	0.0054	0.0150	0.0292	0.0480	0.0711	0.0984	0.1295
0.1642	0.2022	0.2429	0.2862	0.3316	0.3785	0.4266	0.4755
0.5245	0.5734	0.6215	0.6684	0.7138	0.7571	0.7978	0.8358
0.8705	0.9016	0.9289	0.9520	0.9708	0.9850	0.9946	0.9994

Note: The taper region should not change with different CP → Nt = Alpha*Nfft.

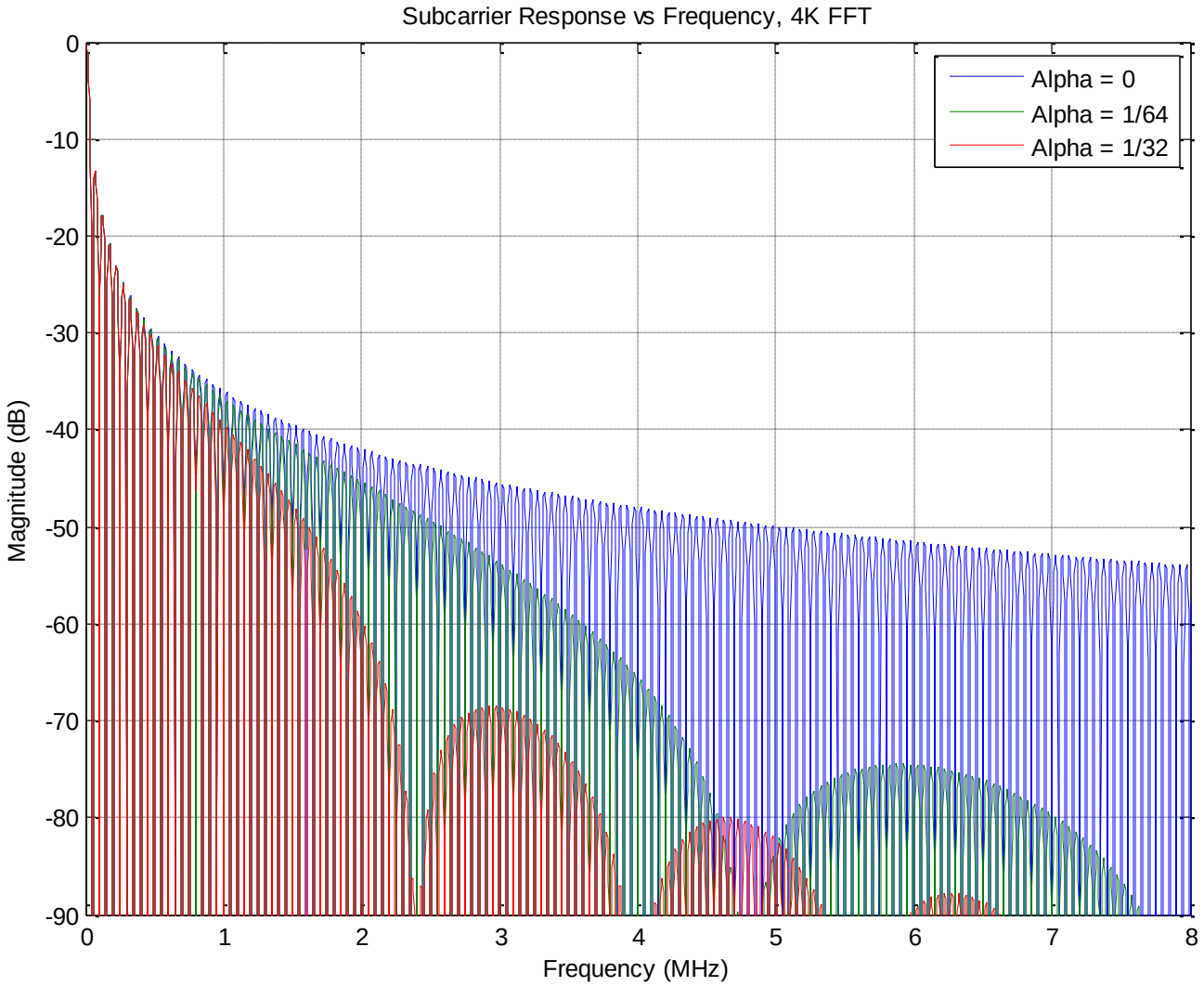
OFDM TX Windowing, RX sampling offset unaffected by TX Windowing



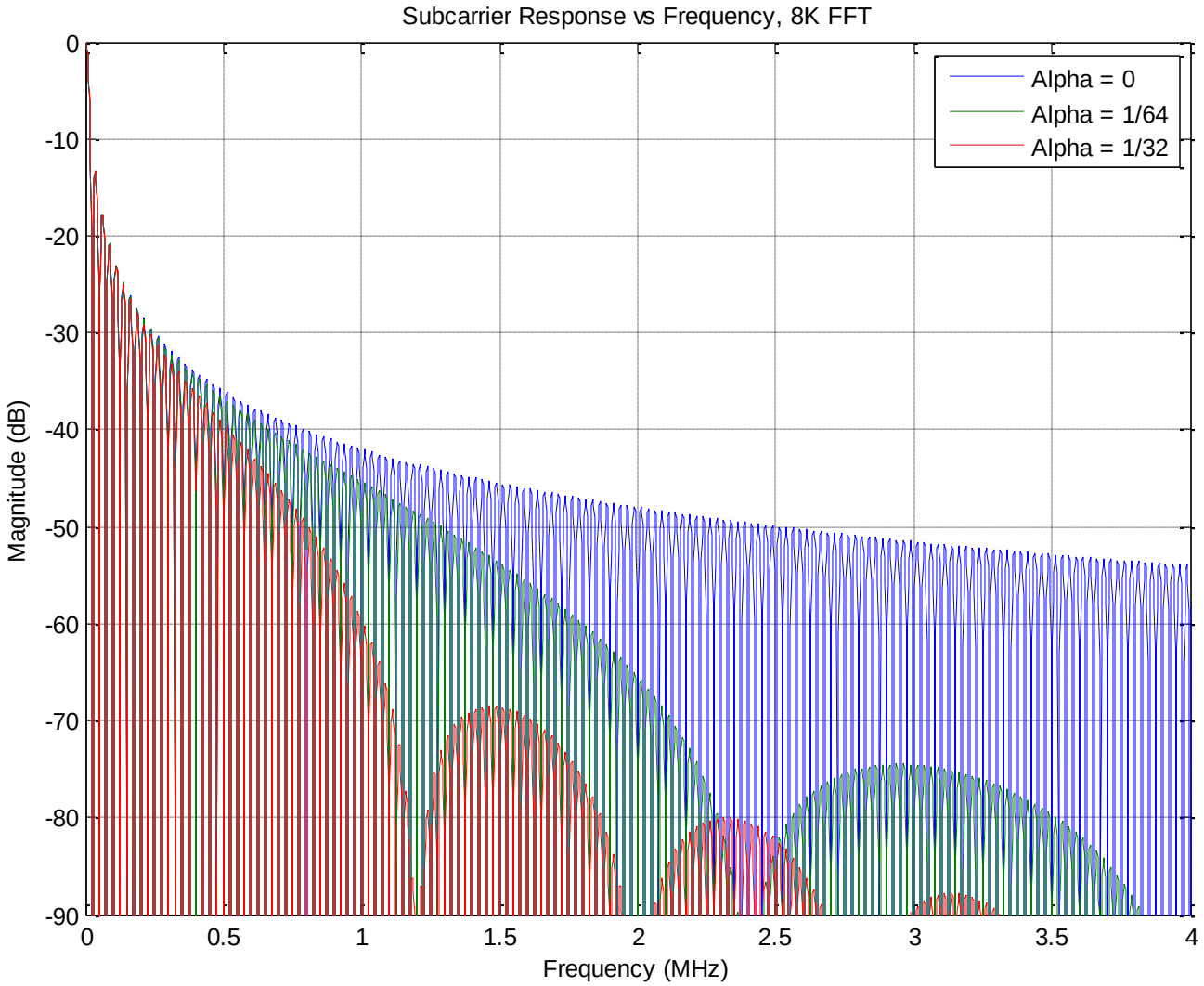
Note: T_s is independent of RC Window Alpha

Leakage Power in Adjacent & In-band 6 MHz Bandwidth

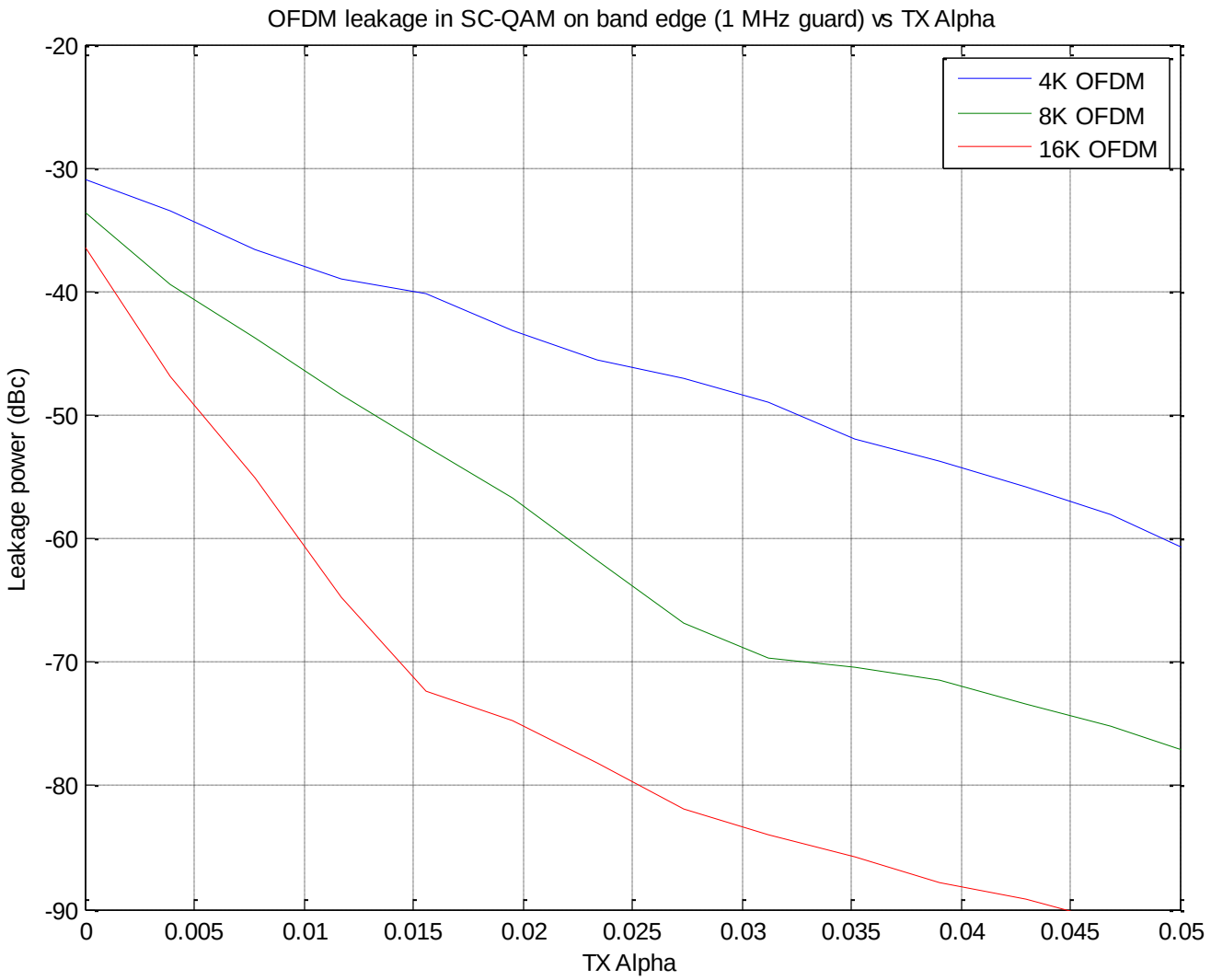
Per Subcarrier FD Response, 4K FFT with Raised-Cosine Window



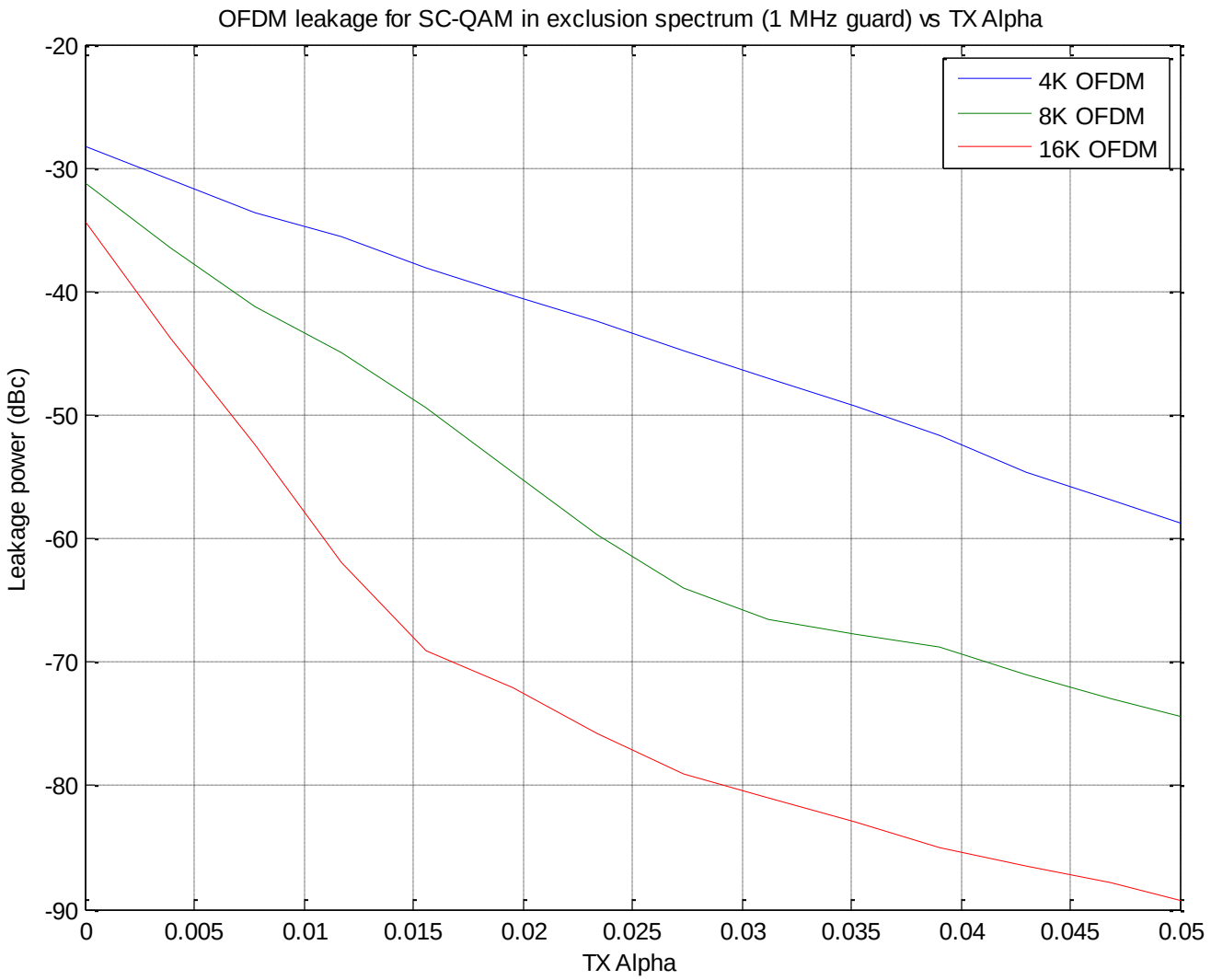
Per Subcarrier FD Response, 8K FFT with Raised-Cosine Window



Power in 6 MHz BW at Band-Edge with 1.0 MHz Guard Band vs. TX Alpha

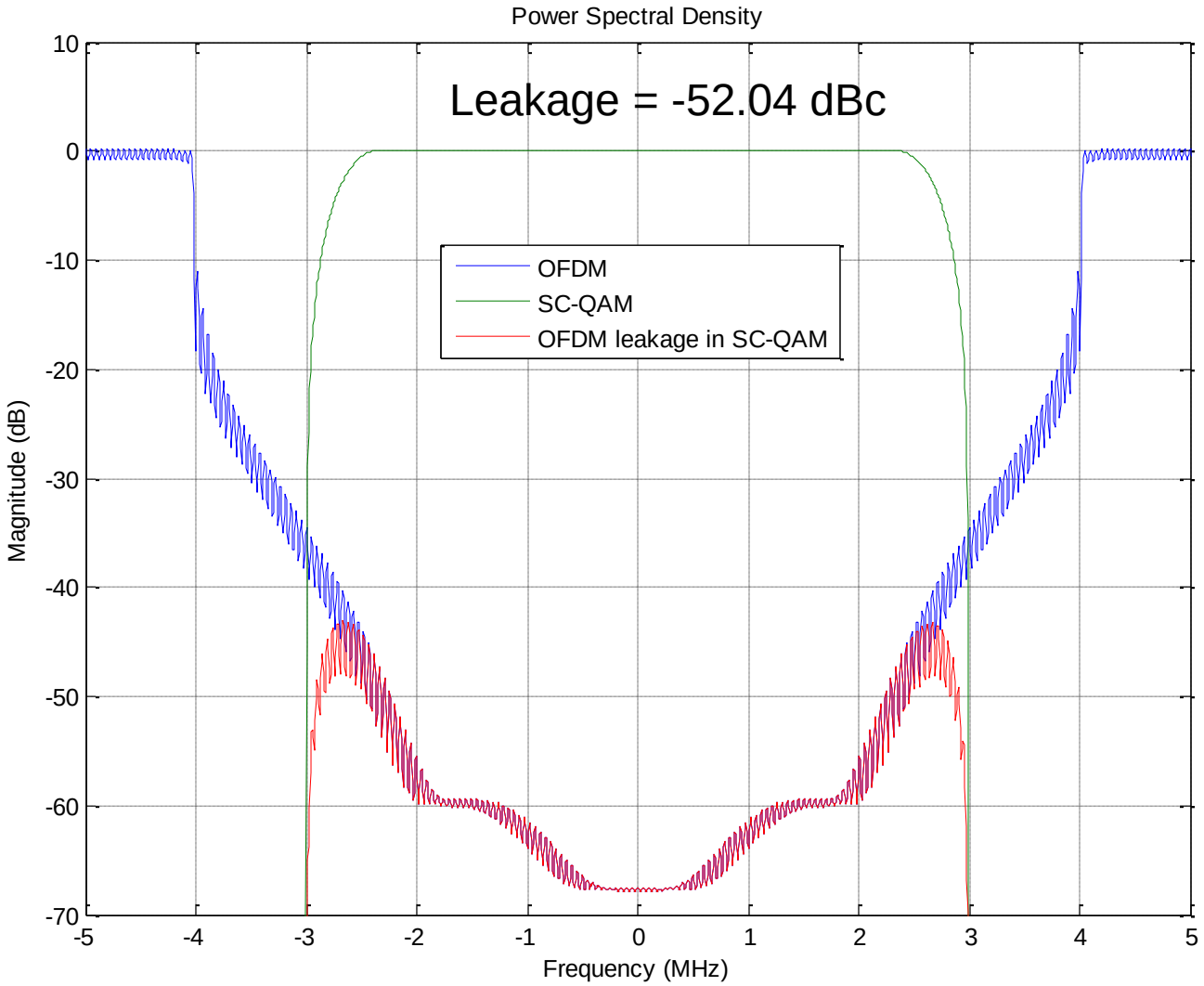


Power in 6 MHz BW In-Band with 1.0 MHz Guard Band vs. TX Alpha

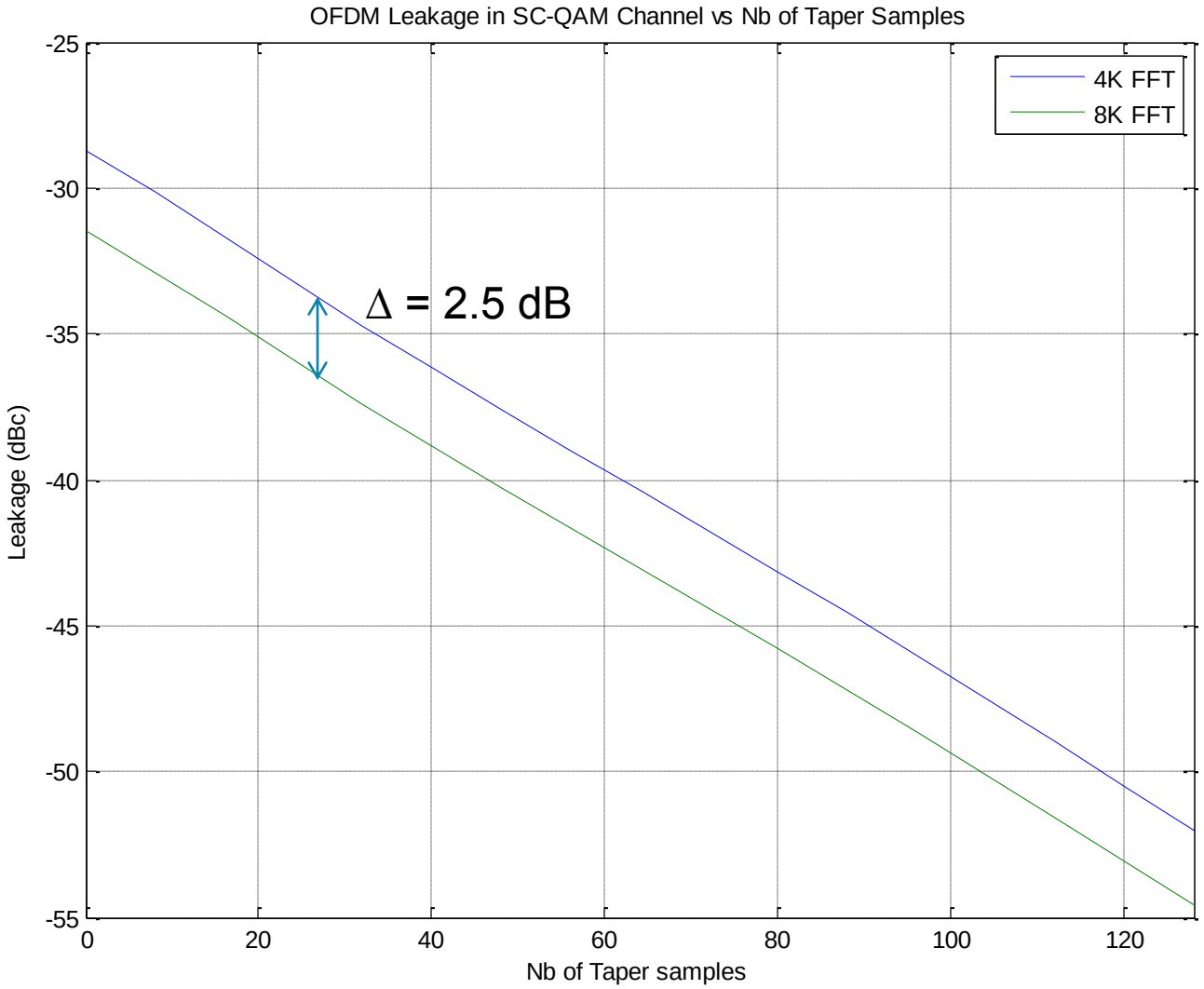


Leakage in Spectral Exclusion for SC-QAM after SQRT RC filter

4K FFT, Alpha TX = 1/32, CP = 1.25 us, 8 MHz Spectral Exclusion, SC-QAM 5.35 Mbaud

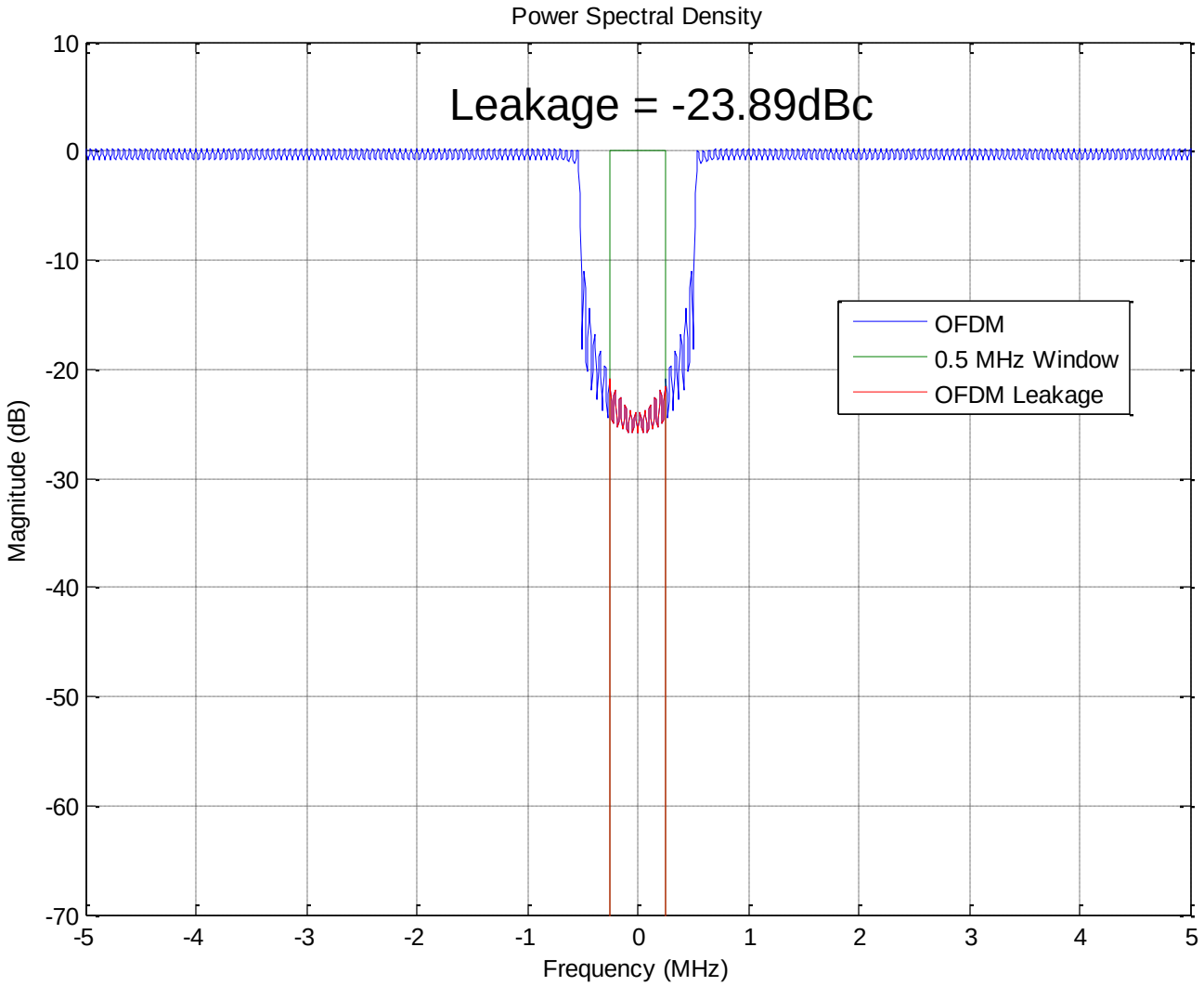


4K & 8K FFT, CP = 1.25 us, 8 MHz Spectral Exclusion, SC-QAM 5.35 Mbaud

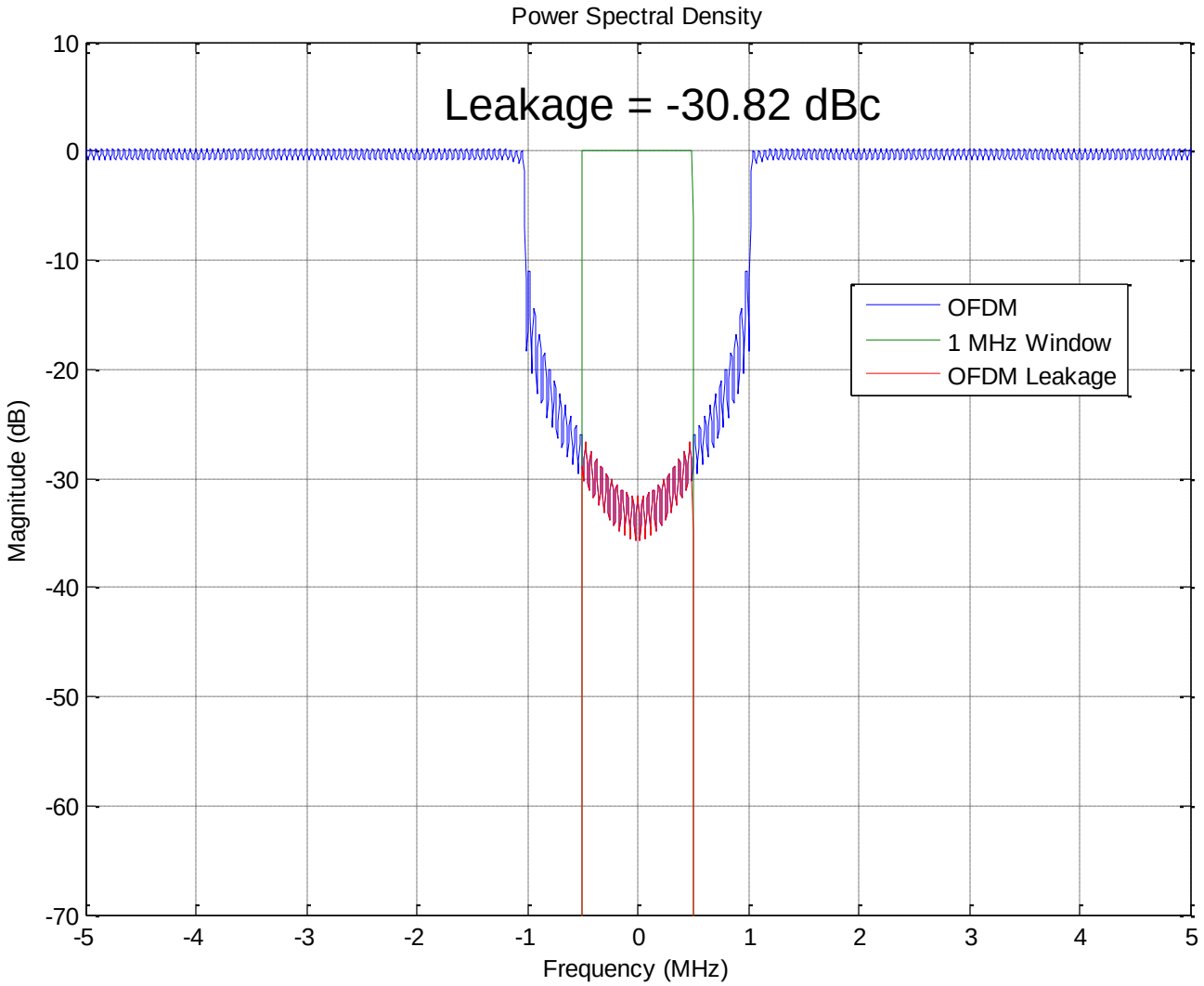


Leakage in Spectral Exclusion for Narrow Bandwidth

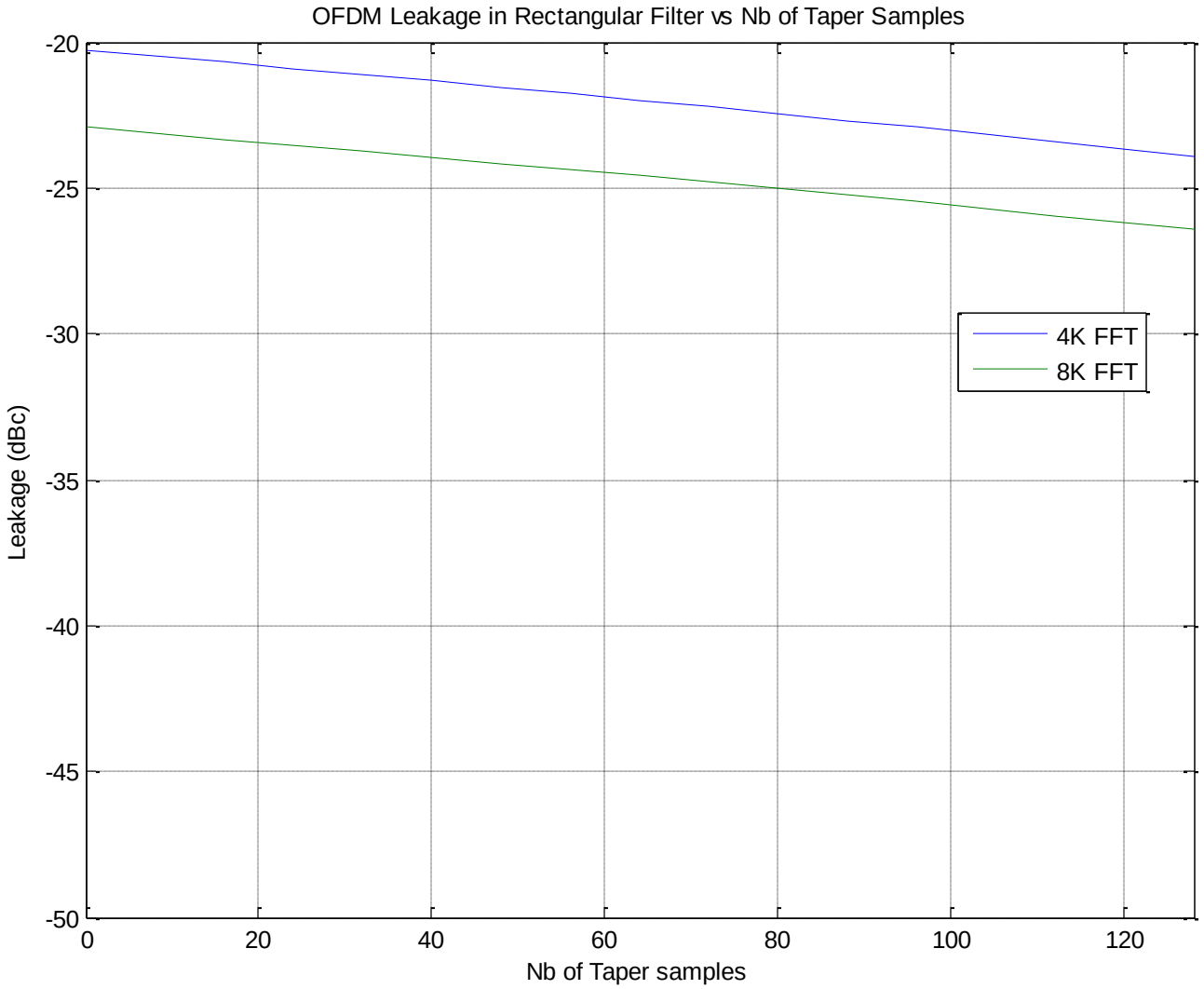
4K FFT, Alpha TX = 1/32, CP = 1.25 us, 1 MHz spectral exclusion, 0.5 MHz Rectangular Filter



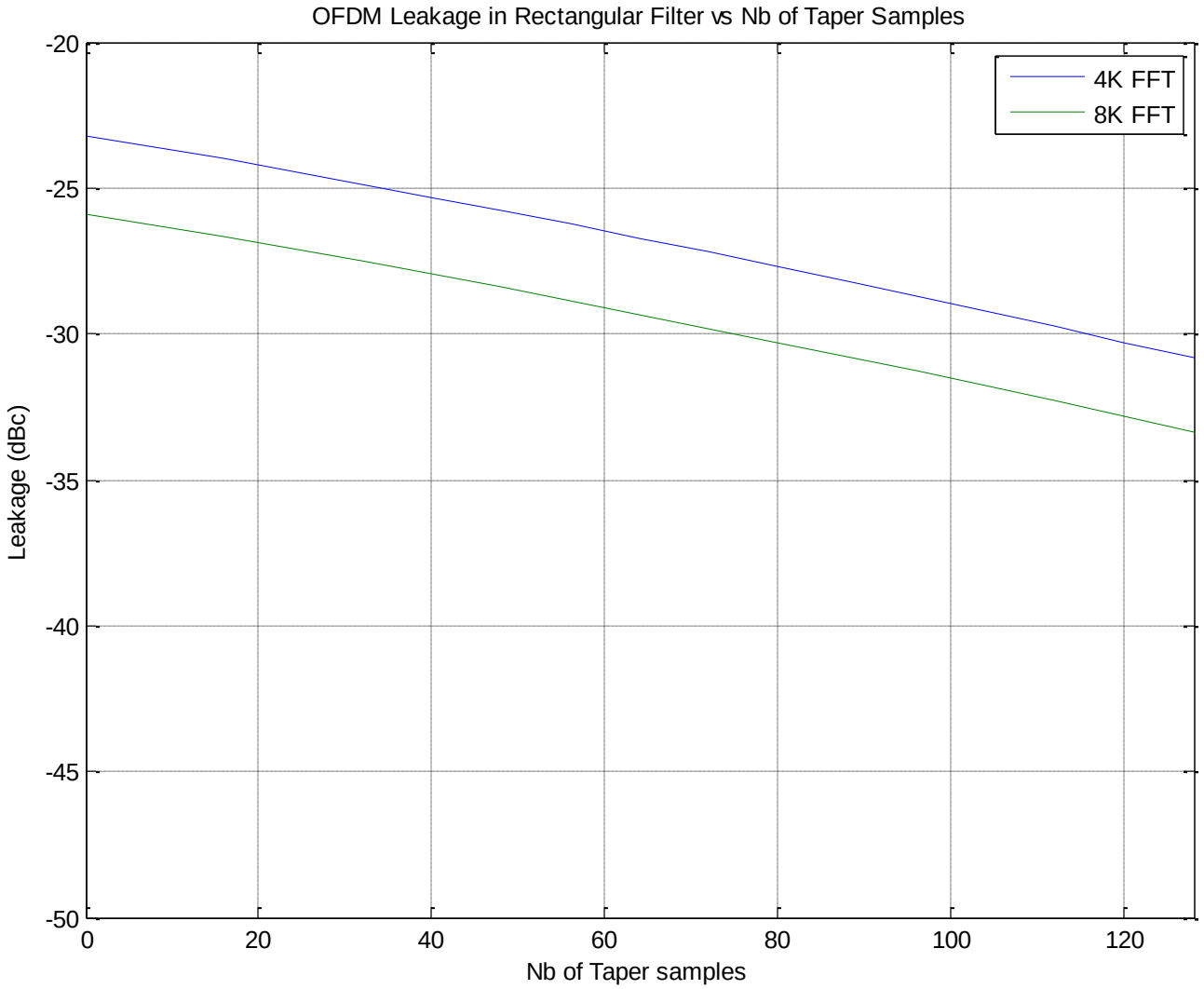
4K FFT, Alpha TX = 1/32, CP = 1.25 us, 2 MHz Spectral Exclusion, 1 MHz Rectangular Filter



4K & 8K FFT, CP = 1.25 us, 1 MHz spectral exclusion, 0.5 MHz Rectangular Filter



4K & 8K FFT, CP = 1.25 us, 2 MHz Spectral Exclusion, 1 MHz Rectangular Filter



Thank You