DAY "0" → FOURIER DOMAIN

DAY "1" → NOISE / UNIT

DAY "2" → CONTROL

$V(t) \rightarrow [nm/s]$

$f_s = 256\ Hz$ $\quad [Hz] = [1/s]$ $\quad \Delta t = 1/f_s = 1/256$ [s]

$T = 1/\text{freq resolution}$

TIME DOMAIN

$V_{RMS} = \sqrt{V(t_1)^2 + V(t_2)^2 + \dots + V(t_N)^2}$

$V_{PEAK} = \sqrt{2}\, V_{RMS}$

FOURIER DOMAIN

$$\tilde{V}(f) = \int_{T=-\infty}^{T=\infty} V(t)\, e^{2\pi i f t}\, dt$$

REALITY (No $-\infty$'s, No $-t$)

"ONE SIDED FFT"

$$\tilde{V}(f) = \int_{T=0}^{T=T} V(t)\, e^{i 2\pi f t}\, dt$$

DISCRETE FOURIER TRANSFORM

$$\tilde{V}(f) = \sum_{n=0}^{N-1} V(t_n)\, e^{2\pi i f t_n}\, \Delta t$$

$N =$ "number of" $= T f_s$

$f = 0, 1/T, 2/T, 3/T, \dots, f_s$

$0 : f_s/T f_s : f \qquad 0 : 1/T : f$

$0 : 1/N\Delta t_s : f_s$

$0 < f < f_s$

MODIFIED DFT

$$\tilde{V}(f) = \sum_{n=0}^{N-1} W(t) \times V(t)\, e^{2\pi i f t}\, \Delta t$$

$[nm/s] \quad [sec] \quad [nm/s] \quad [1/Hz]$

$\left(\sqrt{f_{ms}} \times \text{NENBW}\right) \rightarrow$ UNIQUE PROPERTY OF THE WINDOW FUNCTION, $W(t)$

NORMALIZED EFFECTIVE NOISE BANDWIDTH

$\rightarrow$ ENBW

$$\text{NENBW} = \text{length}(W(t)) \left(\sum_{n=0}^{N-1} W^2(t)\right) \Big/ \left(\sum_{n=0}^{N-1} W(t)\right)^2$$

HANN(ING)

[HAMM]

[BLACKMAN HARRIS]

PERIODOGRAM / POWER SPECTRAL DENSITY / AUTOCORRELATION / PSD

$$S_{VV}(f) \equiv \frac{1}{NT}\left(\sum_{n=0}^{N-1} V(t_n) e^{2\pi i f t}\, \Delta t\right)\left(\sum_{n=0}^{N-1} V(t_n) e^{2\pi i f t}\, \Delta t\right)^* = [Hz]\,[nm/s]^2/[Hz]^2$$

$$= \frac{1}{NT}\tilde{V}(f)\tilde{V}^*(f) = [nm/s]^2/Hz$$

$$= \frac{1}{NT}\left|\tilde{V}(f)\right|^2$$

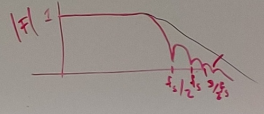
AMPLITUDE SPECTRAL DENSITY / ASD

$$A_{VV}(f) \equiv \sqrt{S_{VV}(f)} = [nm/s]/\sqrt{Hz}$$

PWELCH METHOD

$$\sqrt{\left(\frac{1}{N_{AVGS}} \sum_{n_{AVGS}=1}^{N_{AVGS}} S(f)^2\right)}$$

NYQUIST FREQUENCY $\equiv f_s/2$

ANTI-ALIASING →

TO FILTER OUT FOURIER