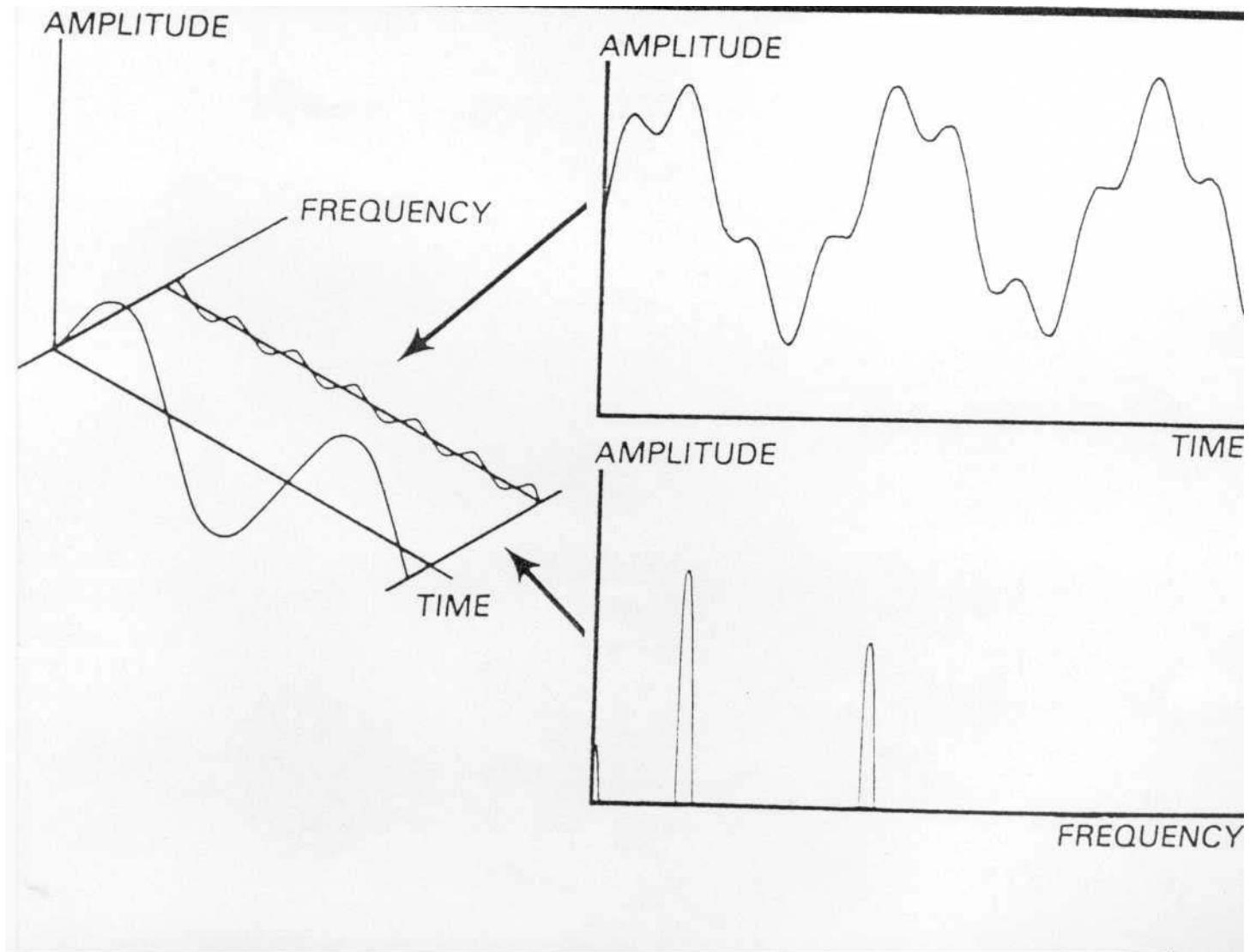


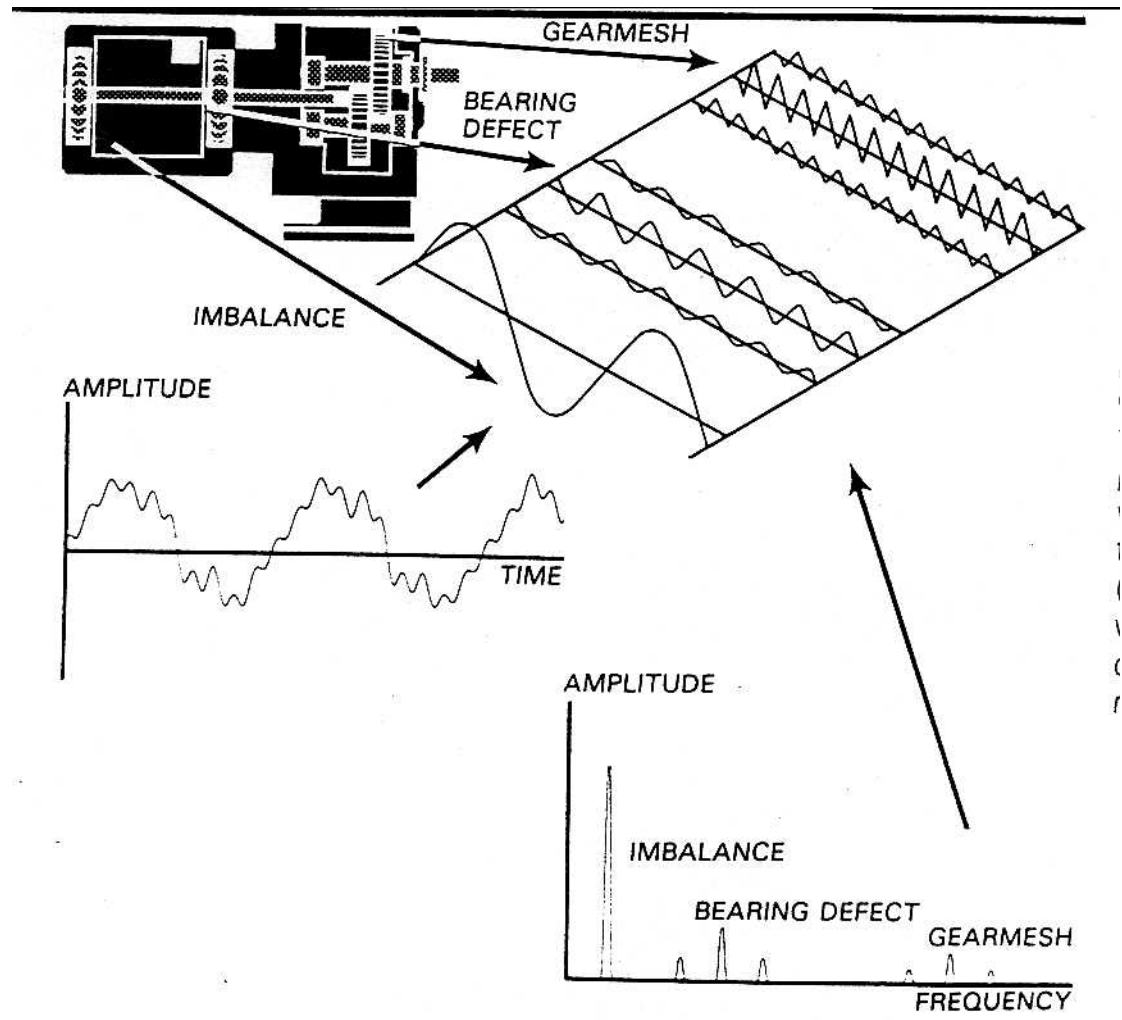
Time – Frequency representation

Time domain: *No spectral information*

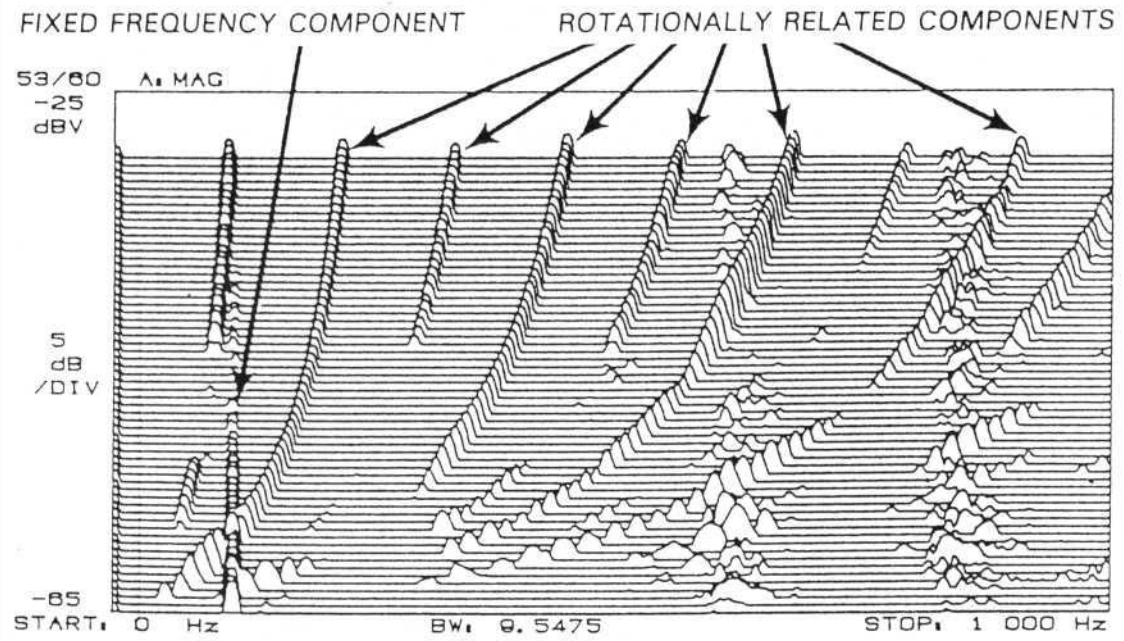
Frequency domain: *No temporal information*



Signal Processing: Time_frequency

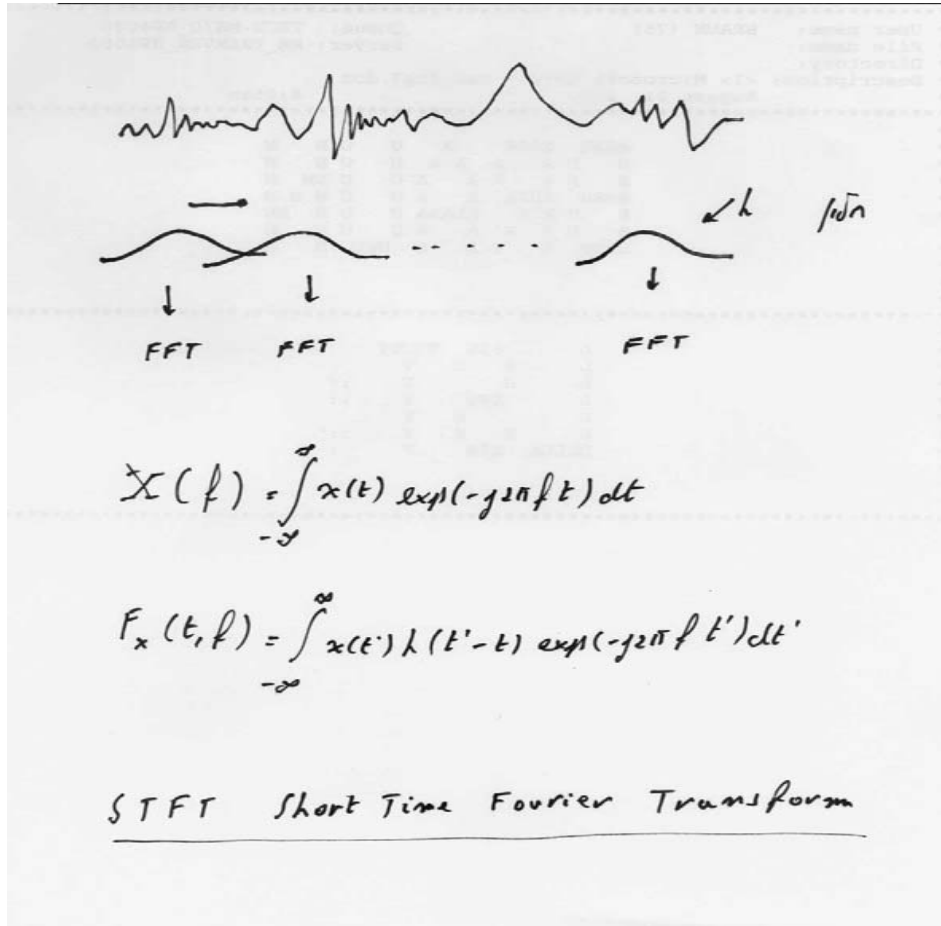


Signal Processing: Time_frequency



Signal Processing: Time_frequency

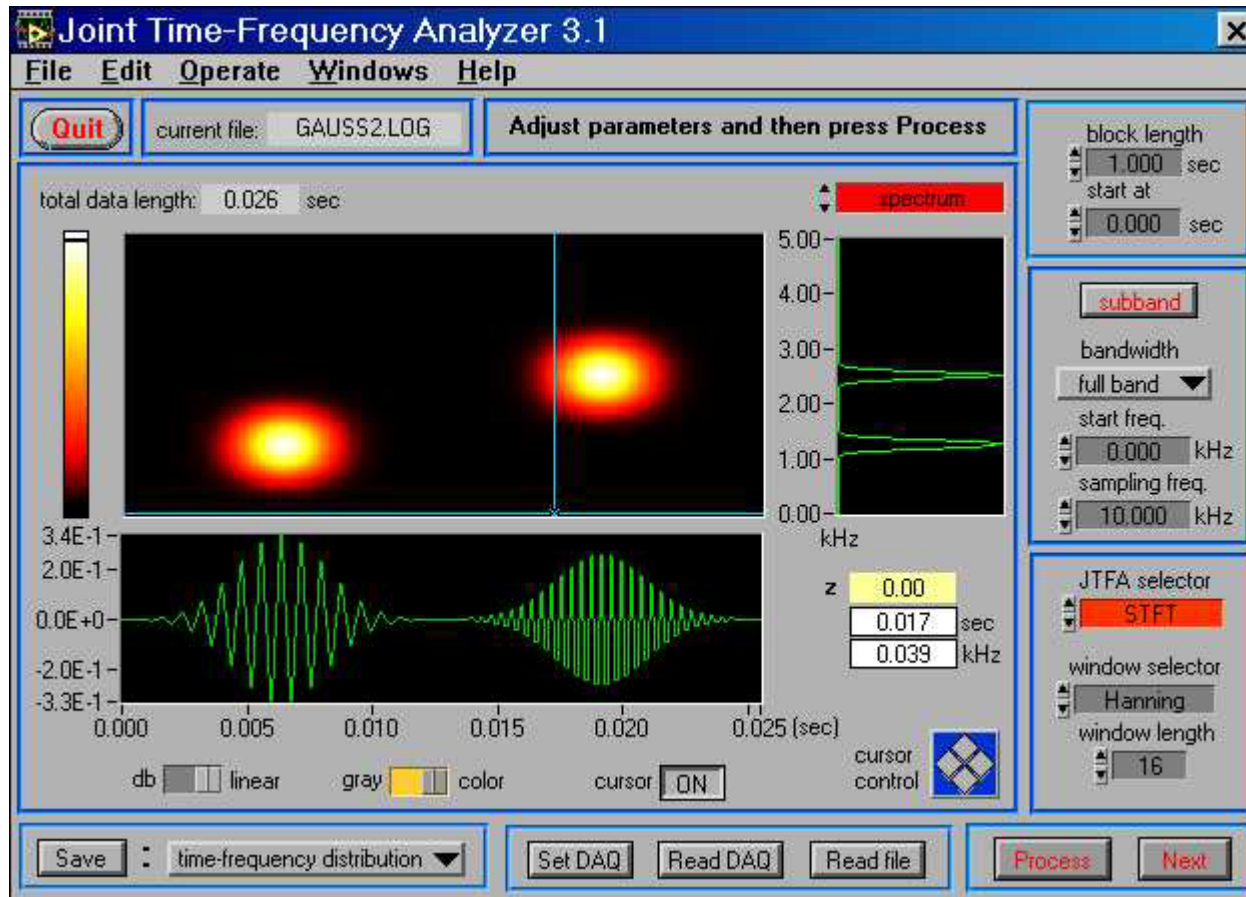
STFT - Short Time Fourier Transform



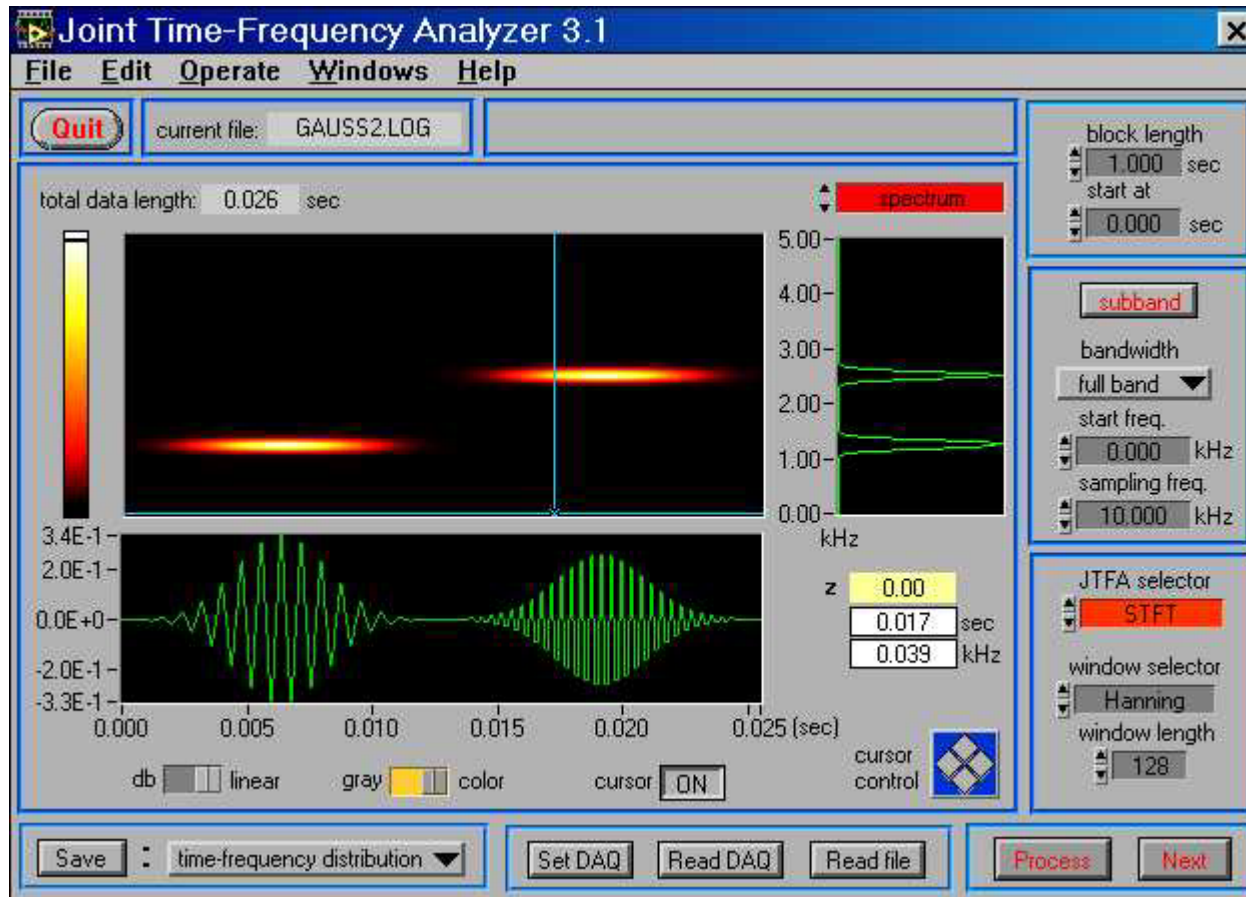
$$F_x(t, f) = \int_{-\infty}^{\infty} x(t') h(t' - t) \exp(-j 2\pi f t') dt'$$

$$x(t) = \frac{1}{E_h} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} F_x(t', f') h(t - t') \exp(j2\pi f' t') df' dt'$$

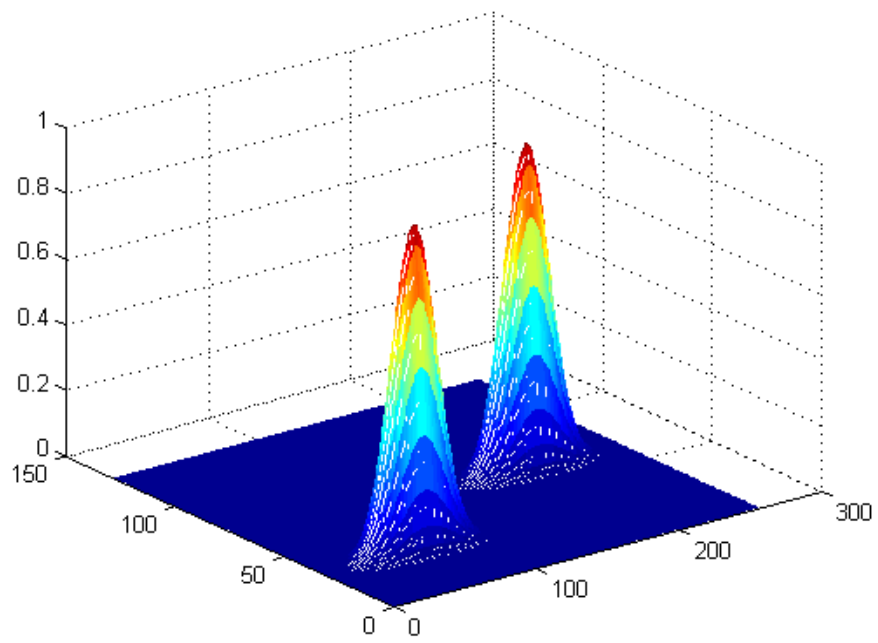
$$E_h = \int_{-\infty}^{\infty} |h(t)|^2 dt$$



Signal Processing: Filters

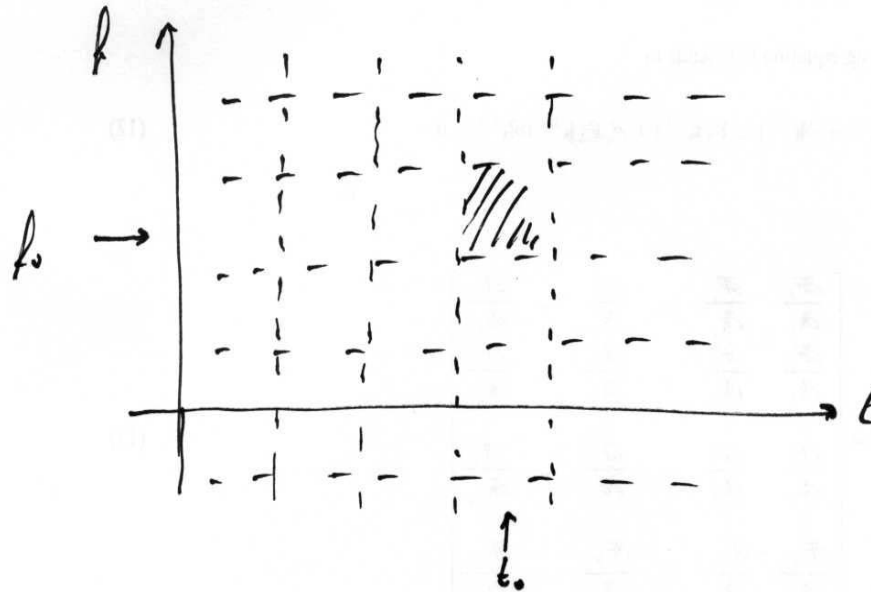


Signal Processing: Time_frequency



Signal Processing: Time_frequency

DISCRETE STFT



$$t = iNT \quad ; \quad f = kof$$

$$F_x(t, f) = \int_{-\infty}^{\infty} x(t') h(t' - t) \exp(-j 2\pi f t') dt'$$

$$x(t) = \frac{1}{E_h} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} F_x(t', f') h(t - t') \exp(j 2\pi t f') df' dt'$$

$$E_h = \int_{-\infty}^{\infty} |h(t)|^2 dt$$

Spectrogram

$$|F_x(t, f)|^2$$

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} |F_x(t, f)|^2 dt df = E_x = \int |x(t)|^2 dt$$