Reflection seismic 1
script

Overview

Fundamentals

Introduction
Seismic waves: Propagation Velocity and Amplitudes
Seismogram

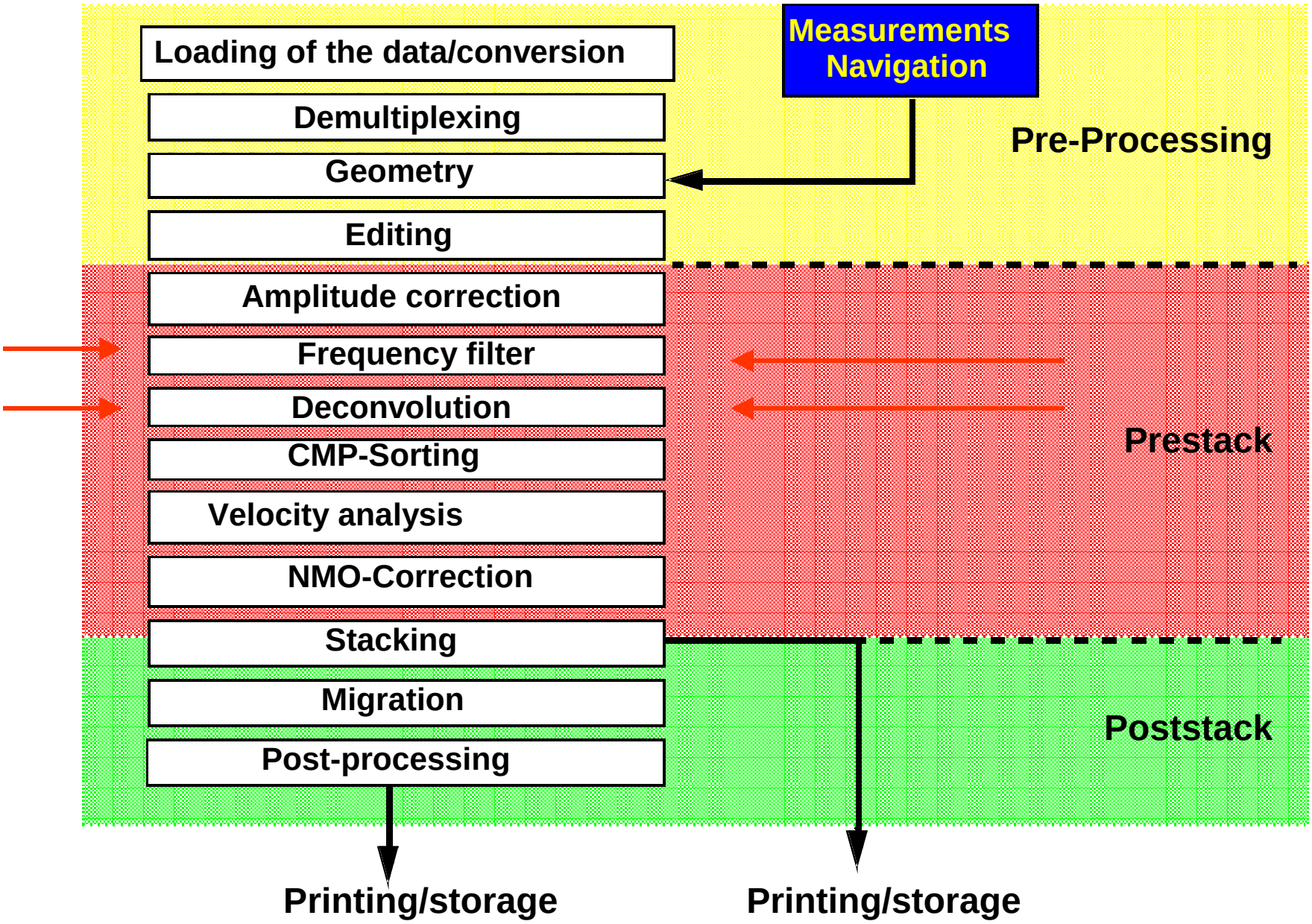
Measurement systems

Sources, receivers, Acquisition strategies

Data processing

“Pre-processing”
Filter und Deconvolution
Velocity anlysis and Stacking
Migration
Interpretation

Basic scheme of the seismic data processing



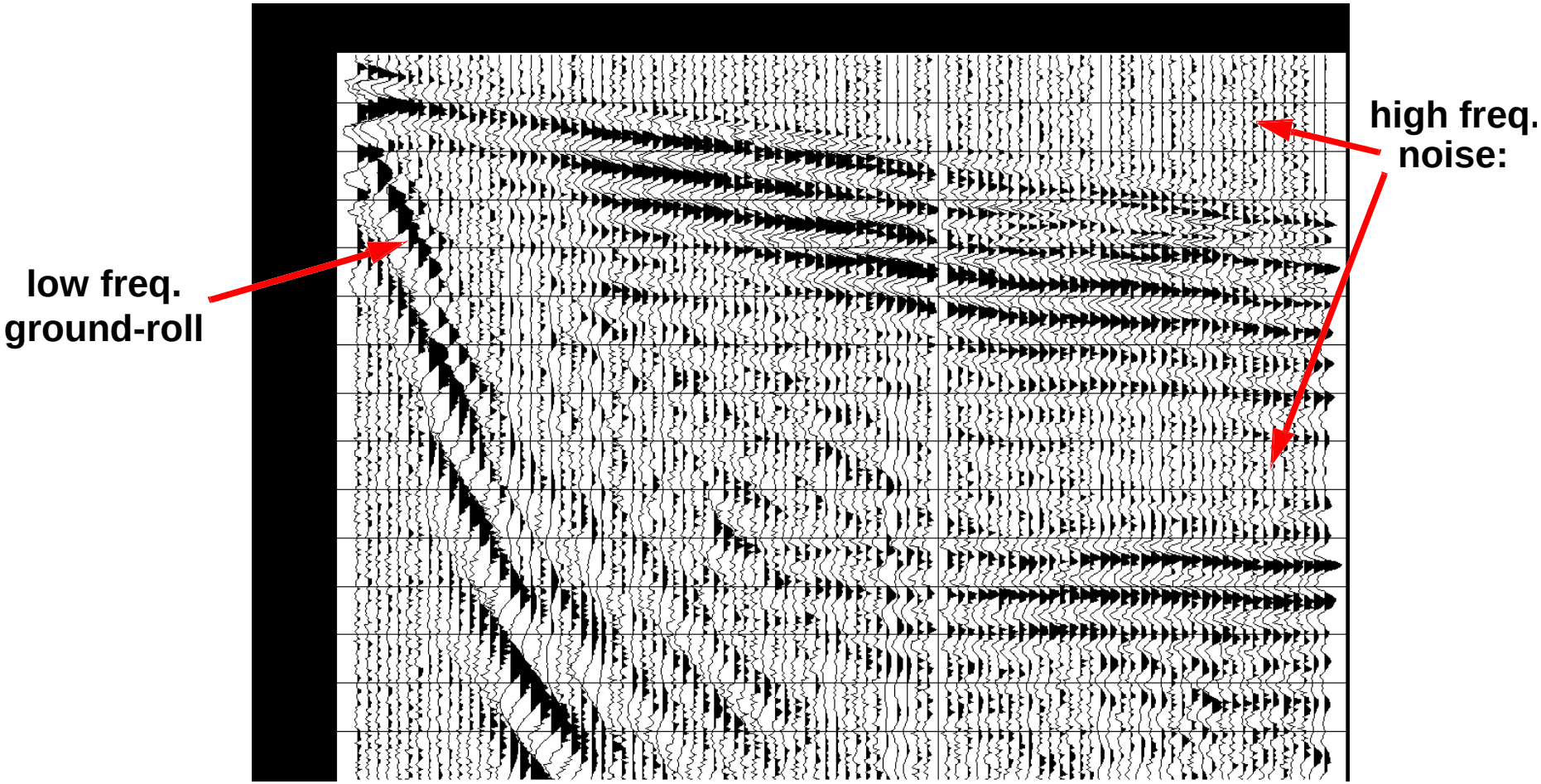
Frequency analysis

- Analysis of the frequency content of the data
- Difference between interface waves, Noise and Reflections
- In what frequency range are the reflections present ?

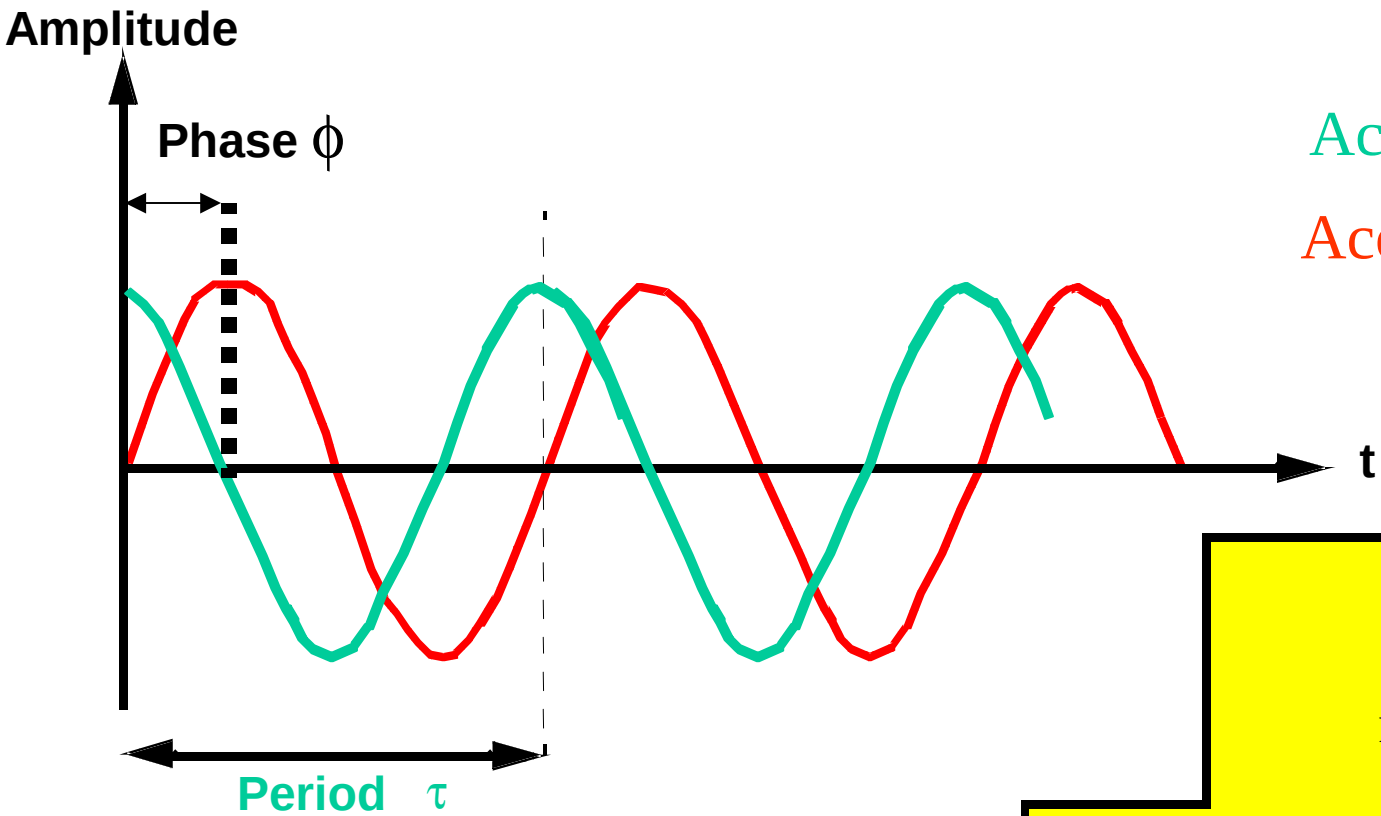
Outline

- Periodic and transient waveforms
- Fourier transformation
  time domain <-> frequency domain
- Frequency filters
- Tapering
- Field examples

Frequency content of a shot



Waves



$A\cos(2\pi ft)$

$A\cos(2\pi ft-\phi)$

Wavelength $\lambda=\tau*V$

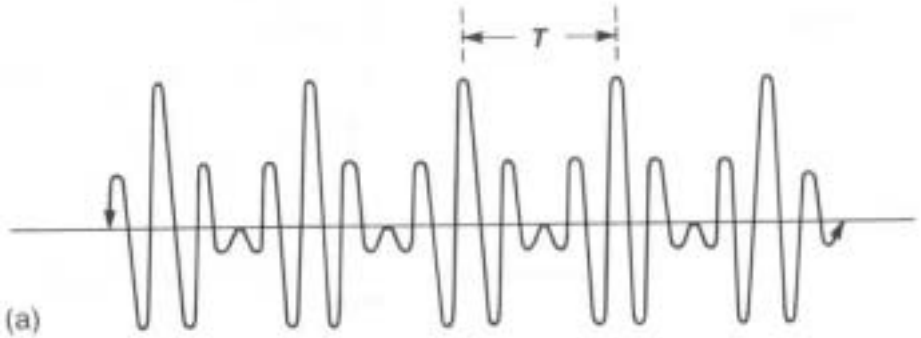
Period $\tau = \frac{1}{f} = \frac{2\pi}{\omega}$

Wavenumber $k = \frac{2\pi}{\lambda}$

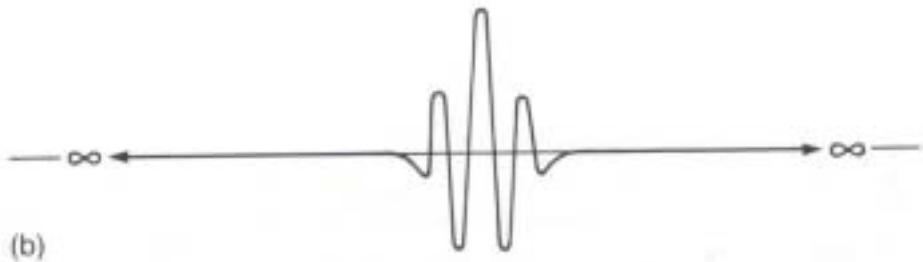
Velocity $v = f\cdot\lambda$

Periodic and transient waveforms

Periodic waveform



Transient waveform



Periodic waveforms

- Any periodic waveform, may be decomposed into a series of sine (or cosine) waves whose frequencies are integer multiples of the basic repetition frequency
- It is necessary to define not only the frequency of each component, but also its amplitude and phase

Fourier transformation

Fourier Transformation:

$$G(f) = \int_{-\infty}^{\infty} g(t) e^{-i 2\pi f t} dt$$

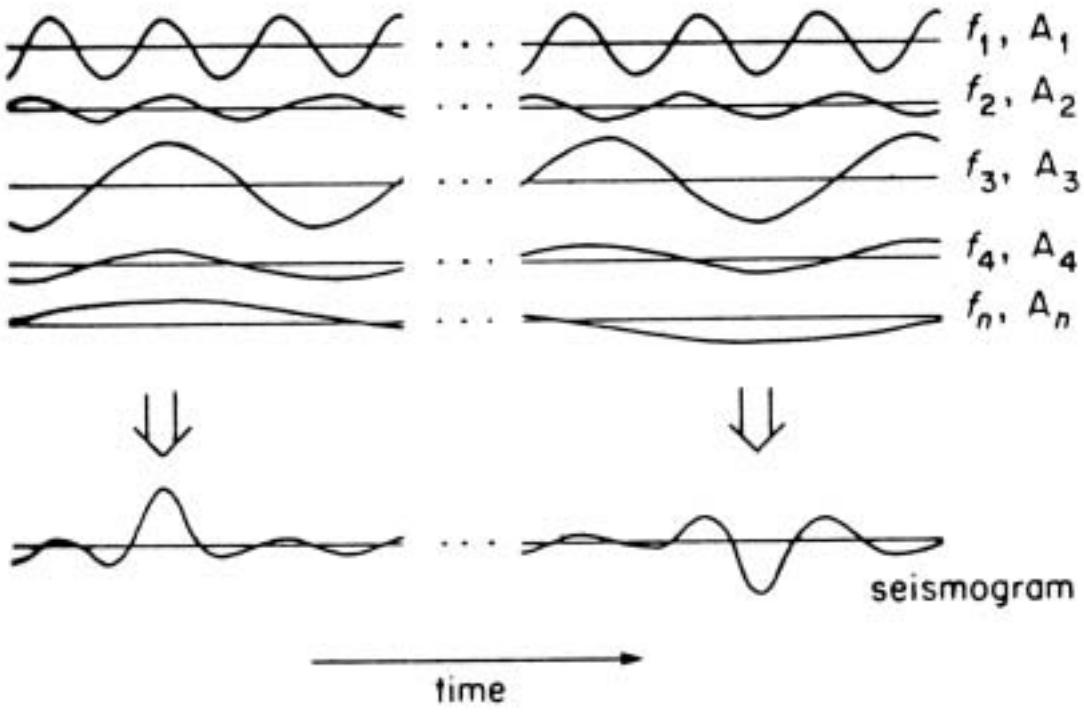
$$G(f) = \int_{-\infty}^{\infty} g(t) \cos(2\pi f t) dt - i \int_{-\infty}^{\infty} g(t) \sin(2\pi f t) dt$$

Inverse Fourier Transformation:

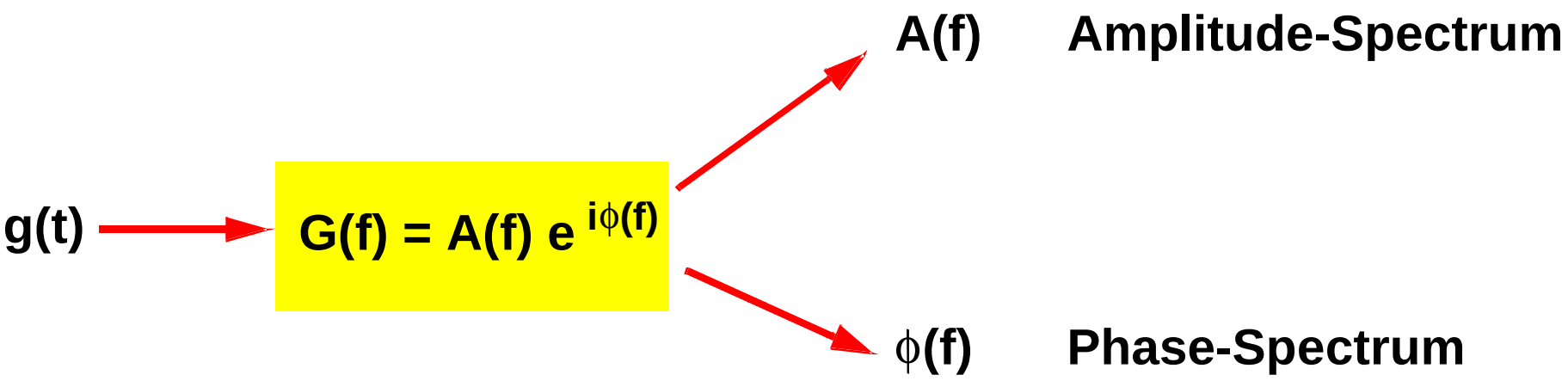
$$g(t) = \int_{-\infty}^{\infty} G(f) e^{i 2\pi f t} df$$

$$g(t) = \int_{-\infty}^{\infty} G(f) \cos(2\pi f t) df + i \int_{-\infty}^{\infty} G(f) \sin(2\pi f t) df$$

Summation of different frequencies

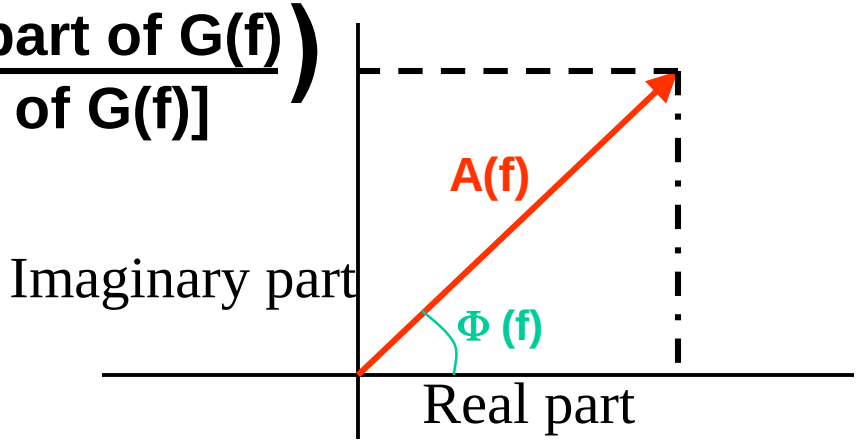


Fourier transformation



where $A(f)=\{[\text{Real part of } G(f)]^2+[\text{Imaginary part of } G(f)]^2\}^{1/2}$

$$\Phi(f)=\tan^{-1}\left(\frac{\text{imaginary part of } G(f)}{\text{real part of } G(f)]}\right)$$

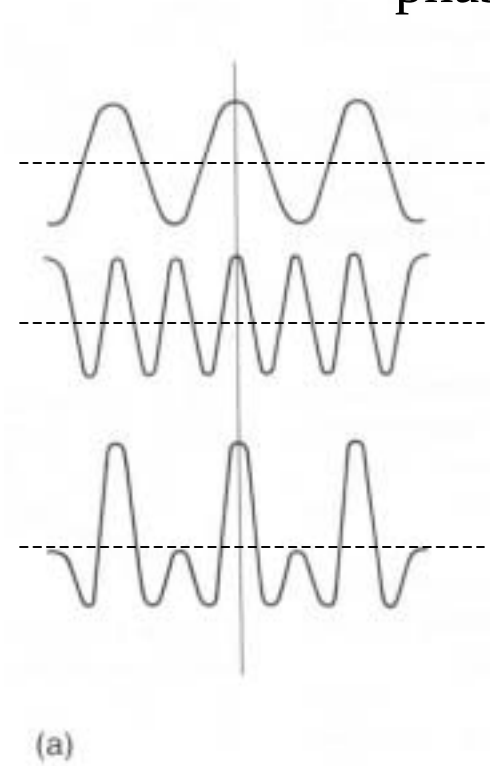


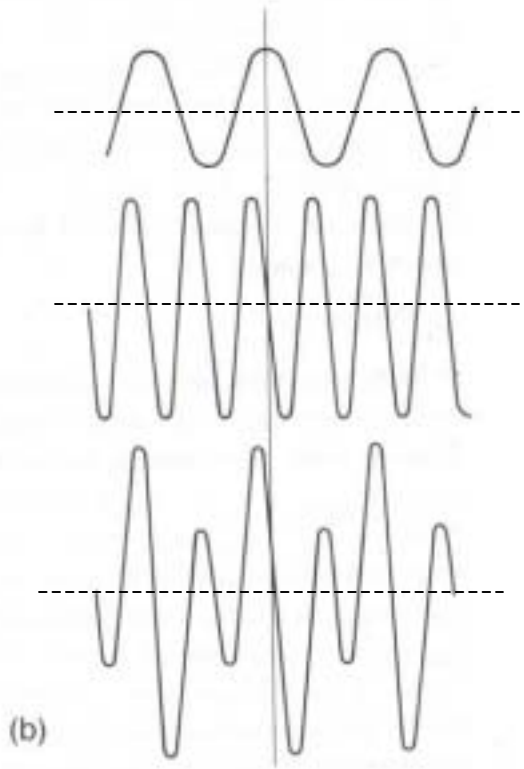
- frequency
- amplitude
- phase

f_1

f_2

Sum:





f_1

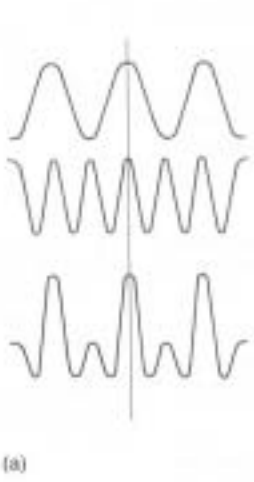
f_2

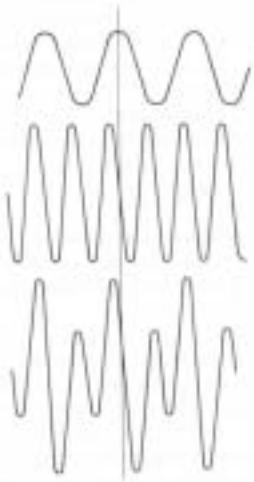
Sum:

f_1

f_2

Sum:

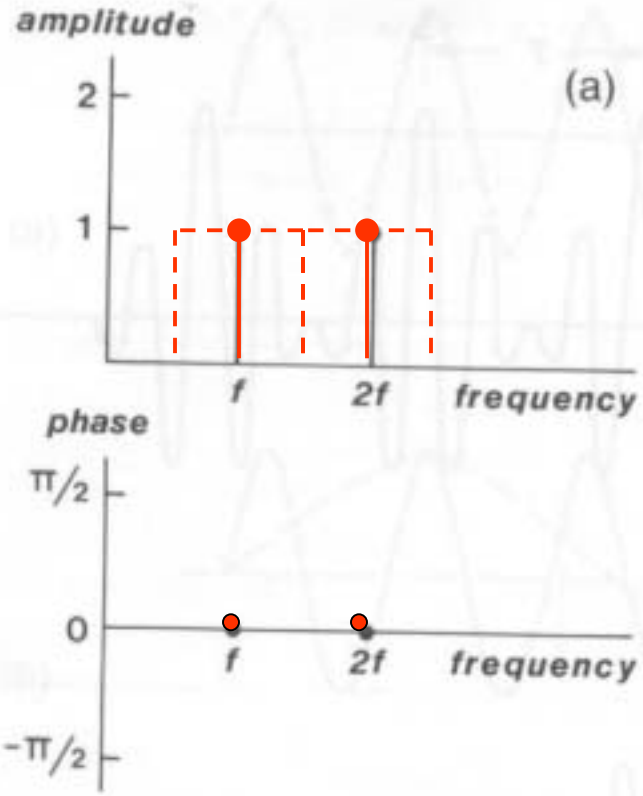


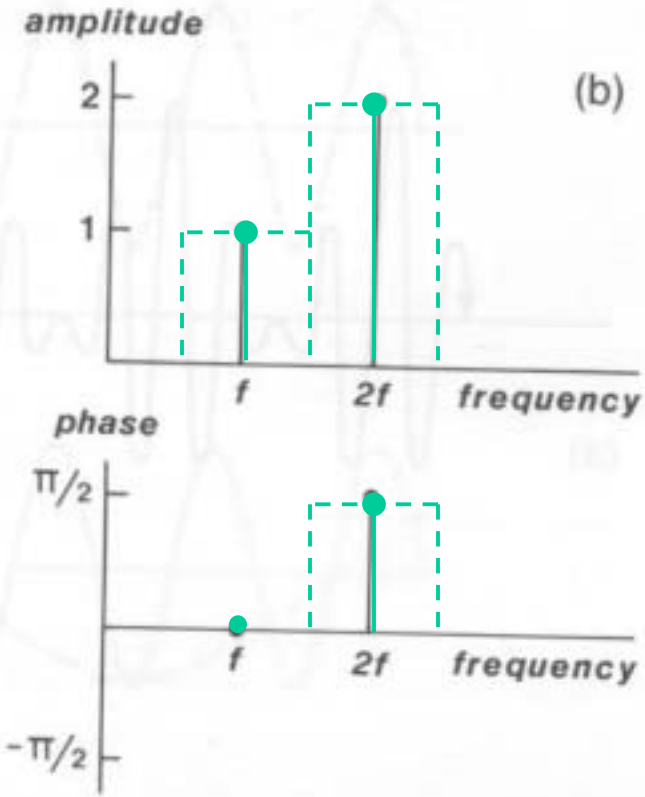


f_1

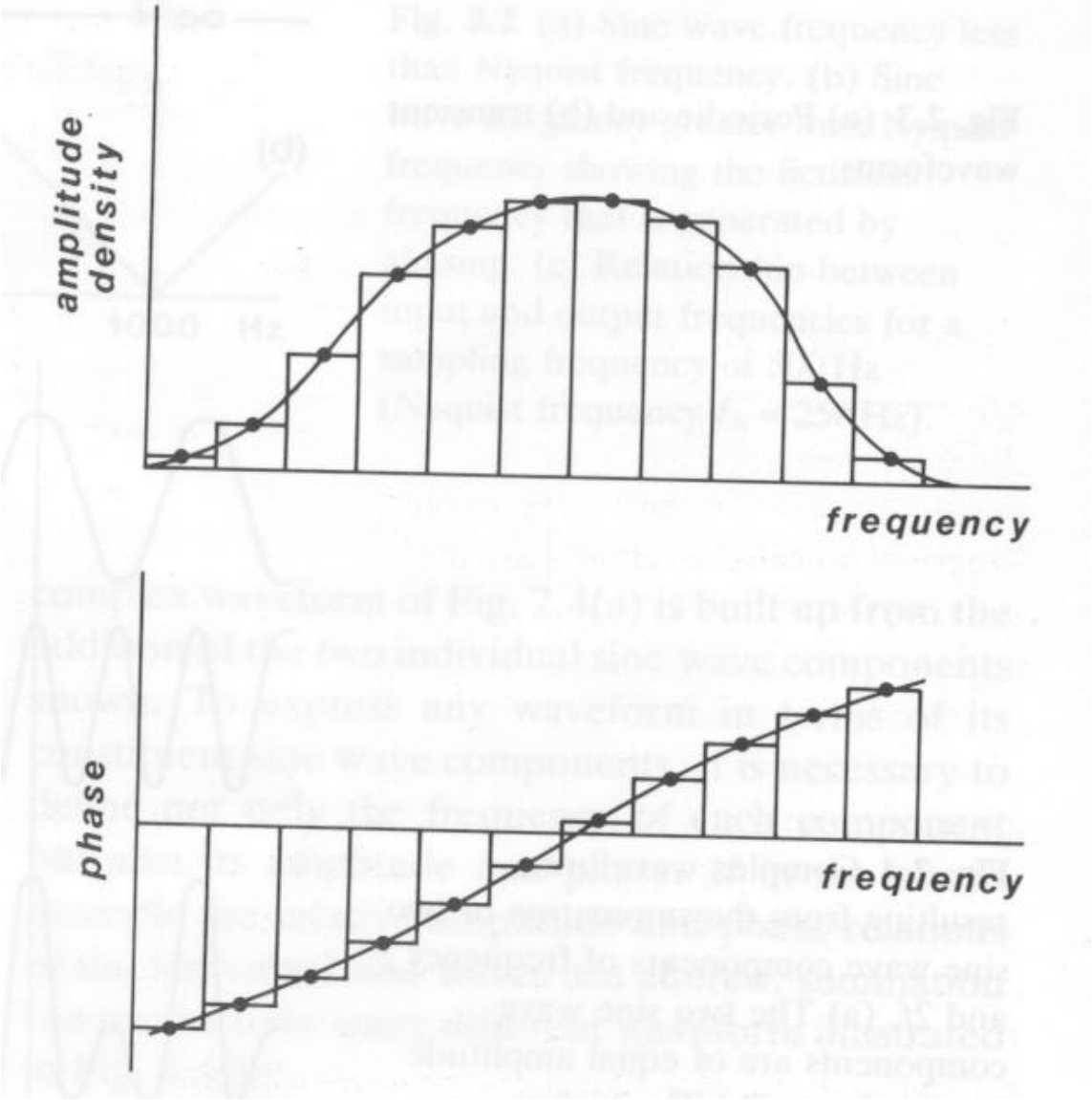
f_2

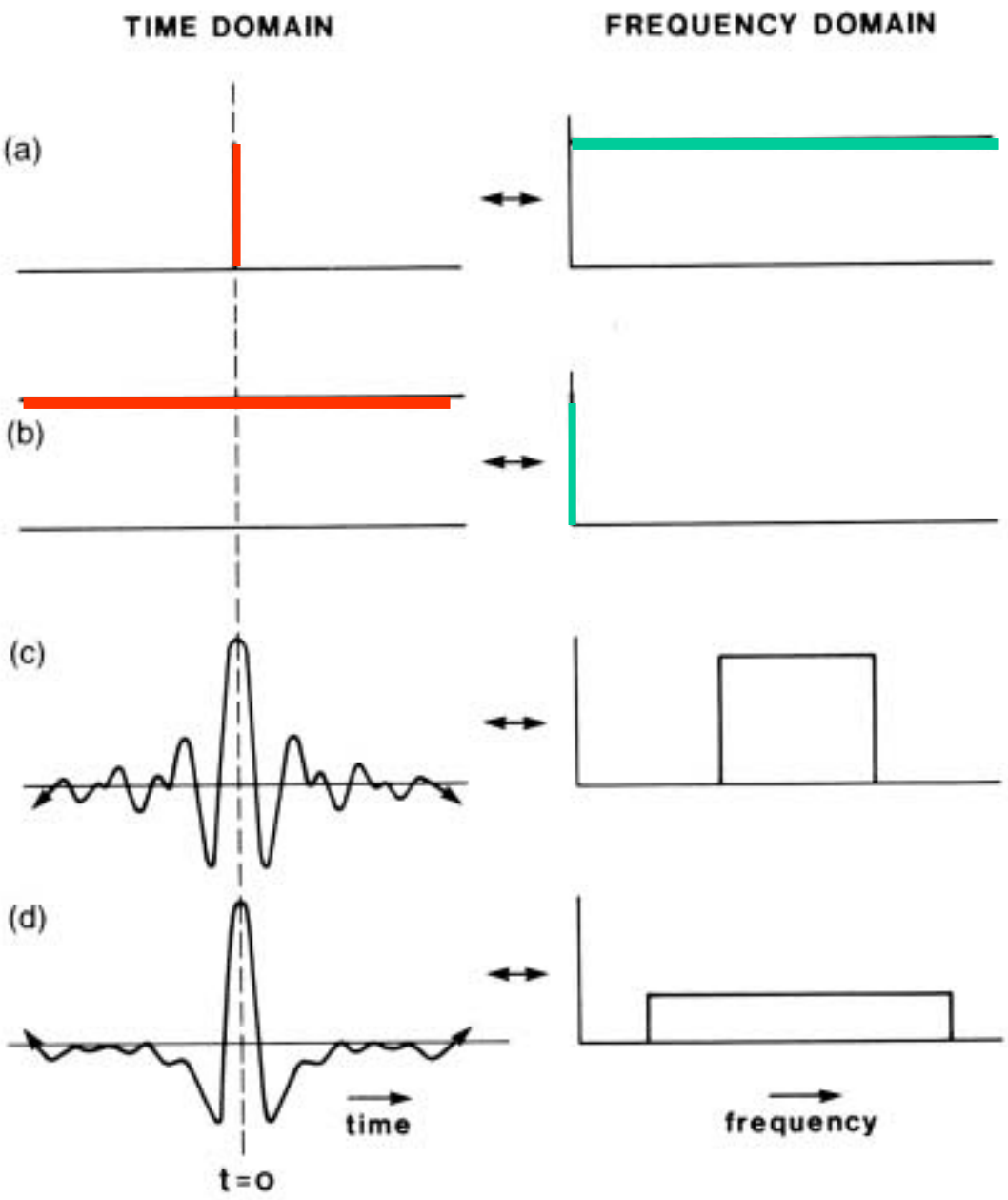
Sum:





Digital representation of continuous amplitude and phase spectrum associated with a transient waveform

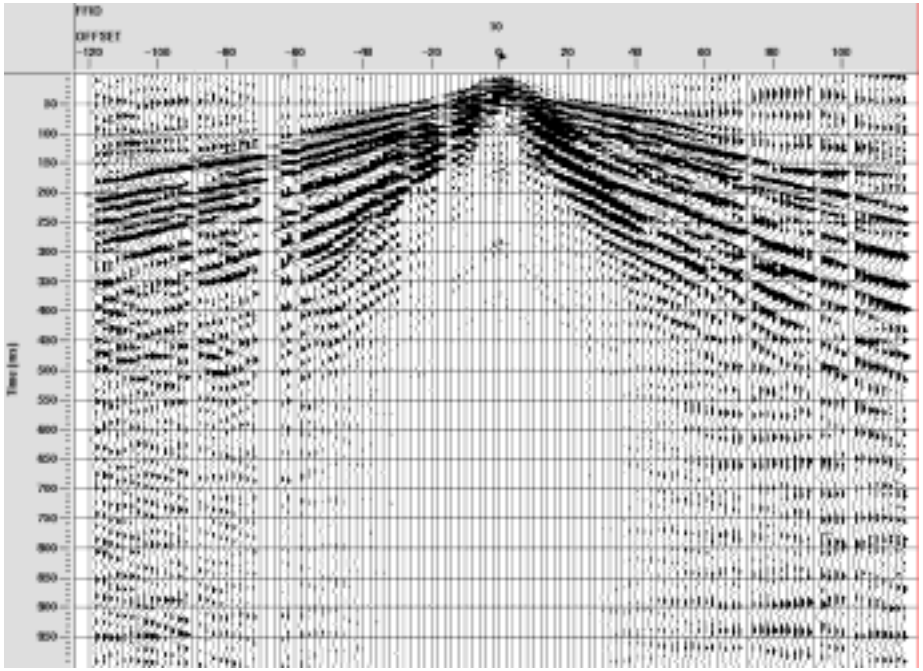


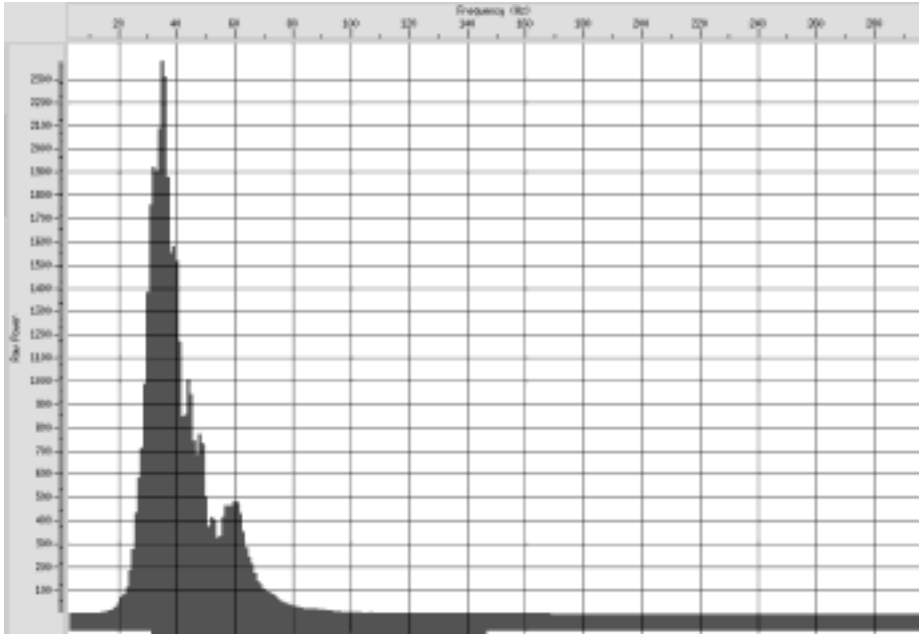


Spike function

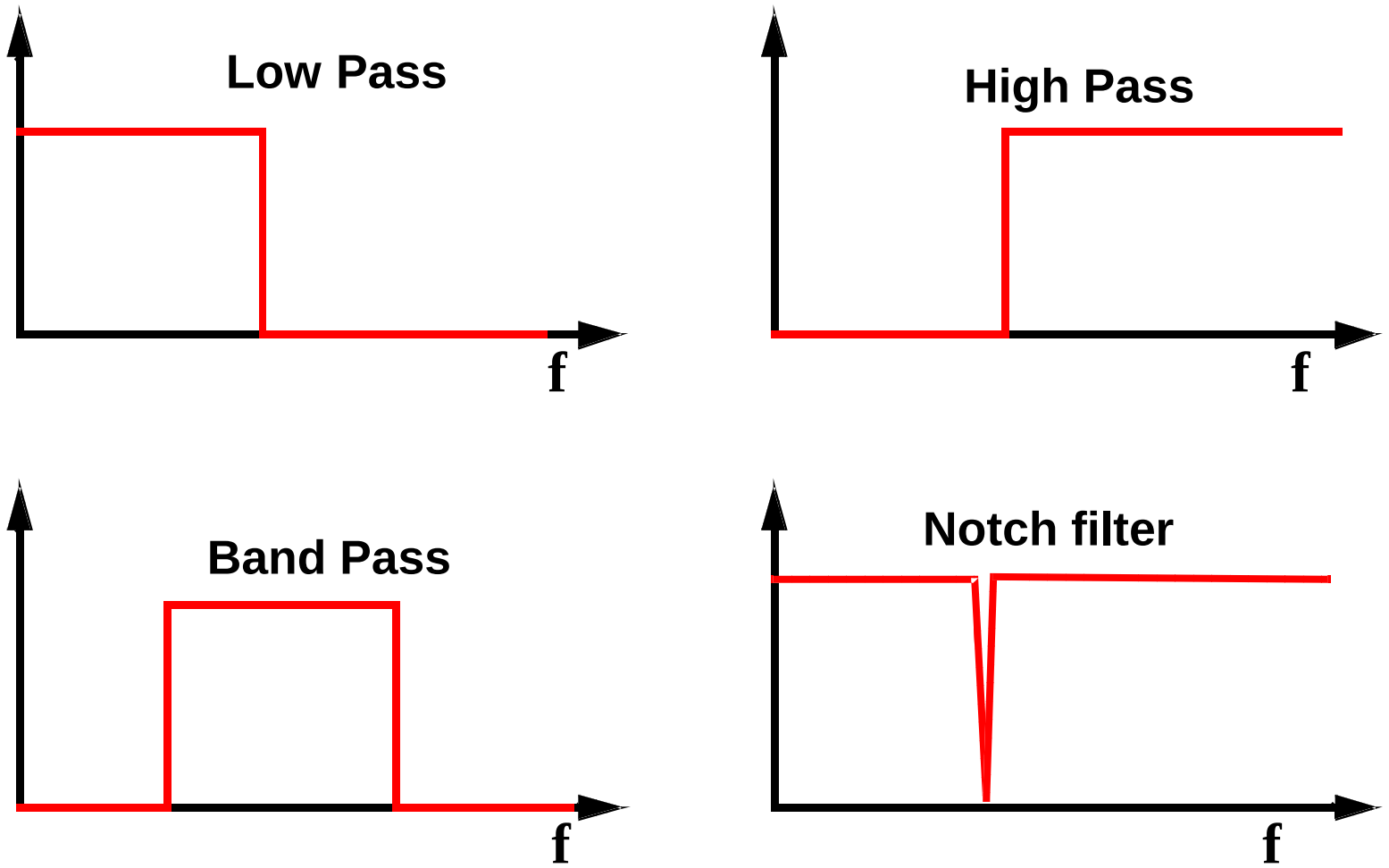
DC bias

Transient waveforms approximating seismic pulses

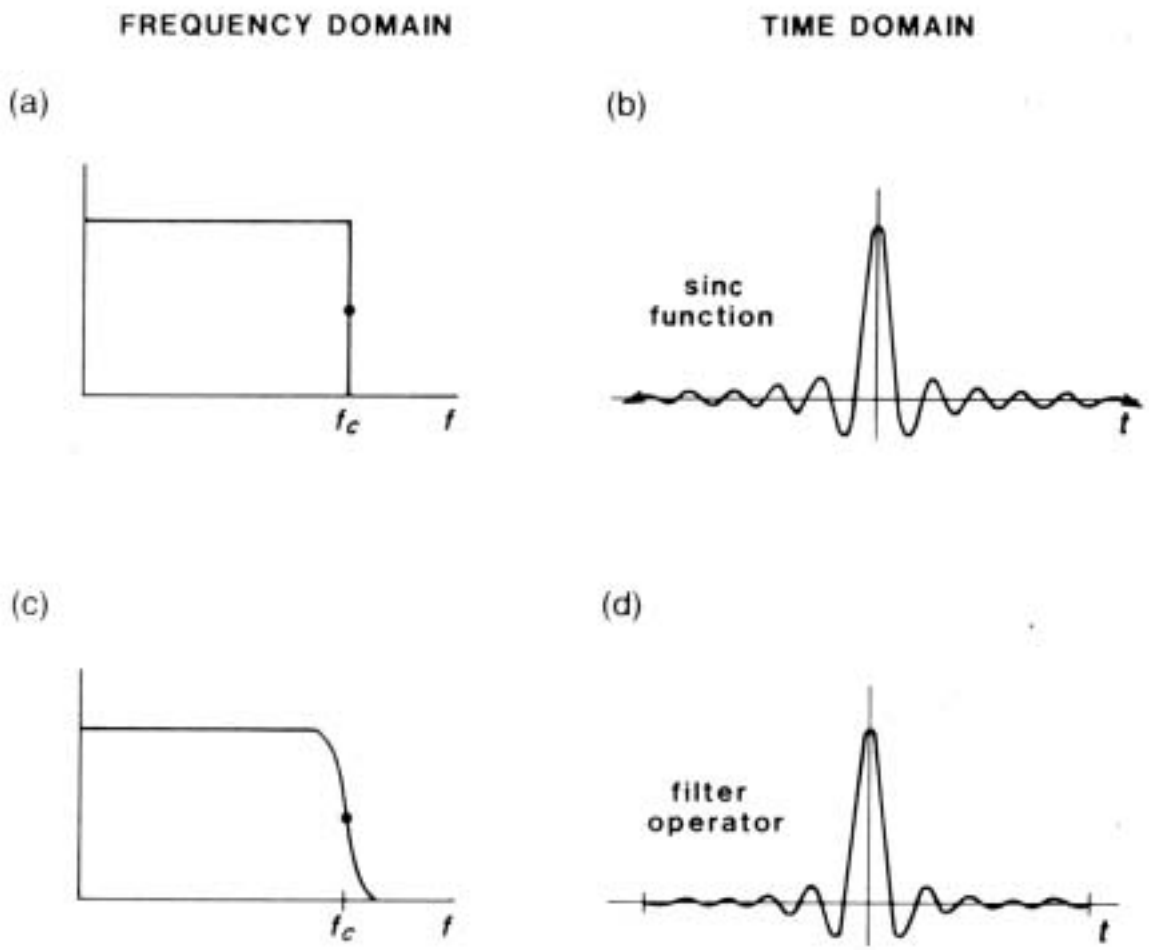

FFID
OFFSET
Time [ms]


Frequency (Hz)
Rel Power

Frequency filter



Tapering

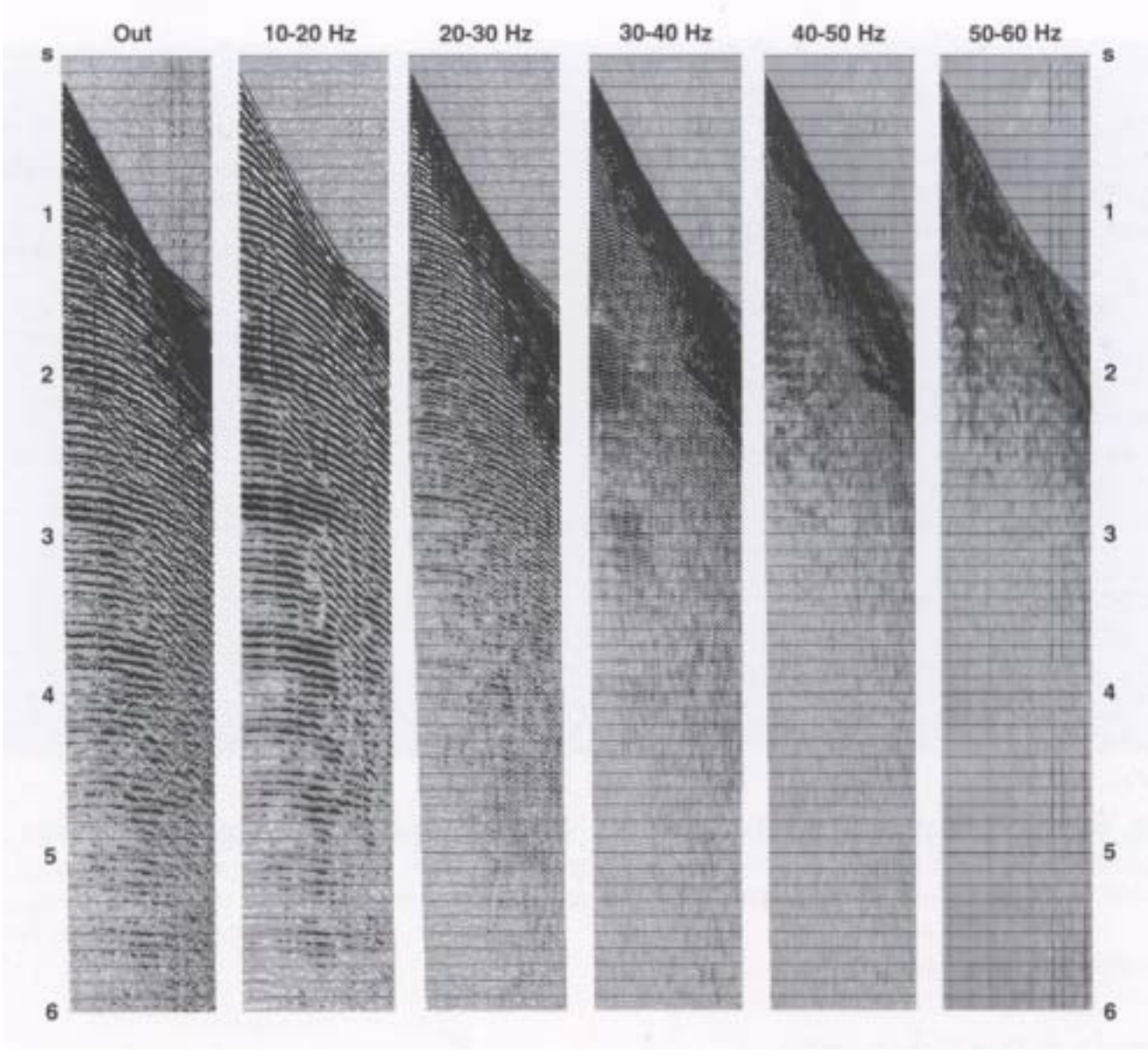

FREQUENCY DOMAIN
TIME DOMAIN
(a)
(b)
sinc
function
f_c
f
t
(c)
(d)
filter
operator
f_c
f
t

Tapering of filters

- Butterworth
- Hanning
- Ormsby

Amplitude and phase characteristics.

Band-pass filtered raw field records



Corrected for geometric spreading: frequency absorption remains