

# F-K Domain Analysis (3A)

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Please send corrections (or suggestions) to [youngwlim@hotmail.com](mailto:youngwlim@hotmail.com).

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# 2D FT seismic example (1)

24 receivers            each with 25m spacing

Time shift 15 ms/trace

Seismogram total length 1sec

Sampling period 0.001 sec       $f_s = 1000 \text{ samples/sec}$

Narrow band signal's frequency 12 Hz

## Phase Velocity?

$$15 \text{ ms/trace} * 23 \text{ trace} = 345 \text{ ms} = 0.345 \text{ sec}$$

$$12 \text{ Hz} \Rightarrow 12 \text{ cycles / sec} * 0.345 \text{ s} = 4.14 \text{ cycles}$$

$$25\text{m spacing} \Rightarrow 25\text{m} * 23 = 575 \text{ m} = 0.575 \text{ km}$$

$$\frac{1}{\lambda} = \frac{4.14 \text{ cycles}}{0.575 \text{ km}} = 7.2 \text{ cycles/km} \qquad k = \frac{2\pi}{\lambda}$$

# 2D FT seismic example (2)

24 receivers each with 25m spacing

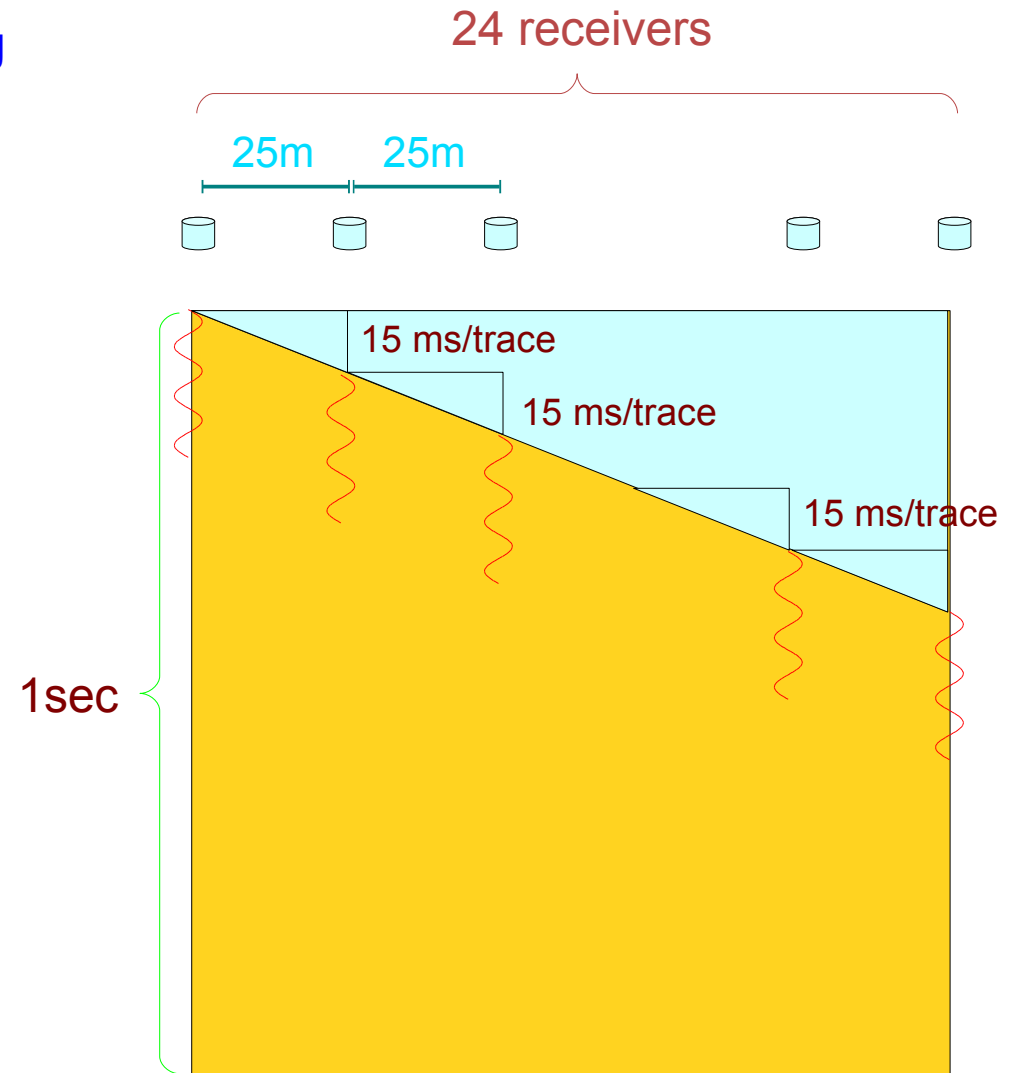
Time Shift 15 ms/trace

Seismogram Total Length 1sec

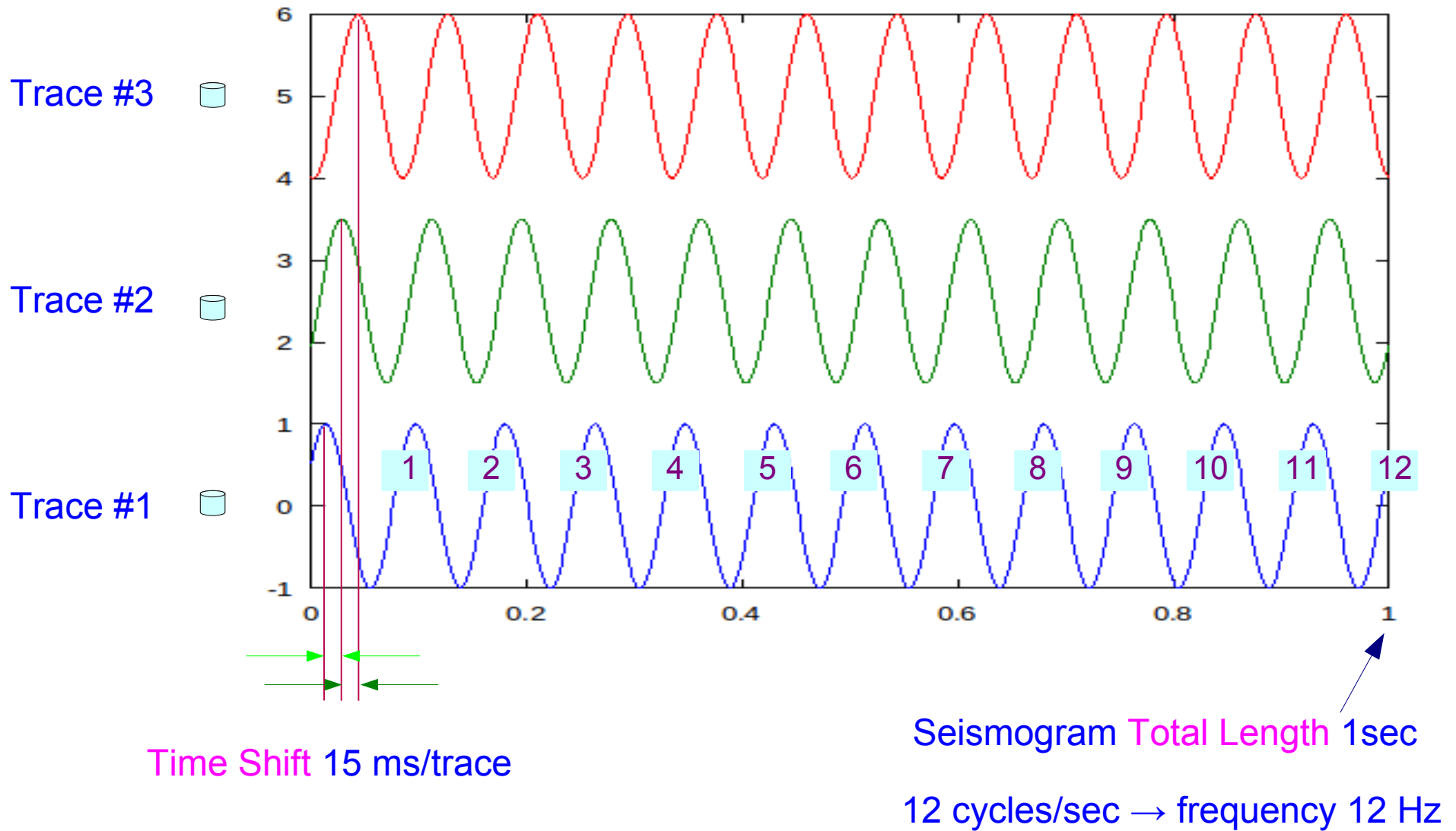
Sampling period 0.001 sec

$$f_s = 1000 \text{ samples/sec}$$

Narrow band signal's frequency 12 Hz



# 2D FT seismic example (3)



# 2D FT seismic example (4)

## Phase Velocity

$$15 \text{ ms/trace} * 23 \text{ trace} = 345 \text{ ms} = 0.345 \text{ sec} = \Delta t$$

$$\frac{\Delta x}{\Delta t} = \frac{0.575 \text{ km}}{0.345 \text{ sec}}$$

$$= 1.67 \text{ km/sec}$$

$$25\text{m} * 23$$

$$= 575 \text{ m}$$

$$\Delta x = 0.575 \text{ km}$$

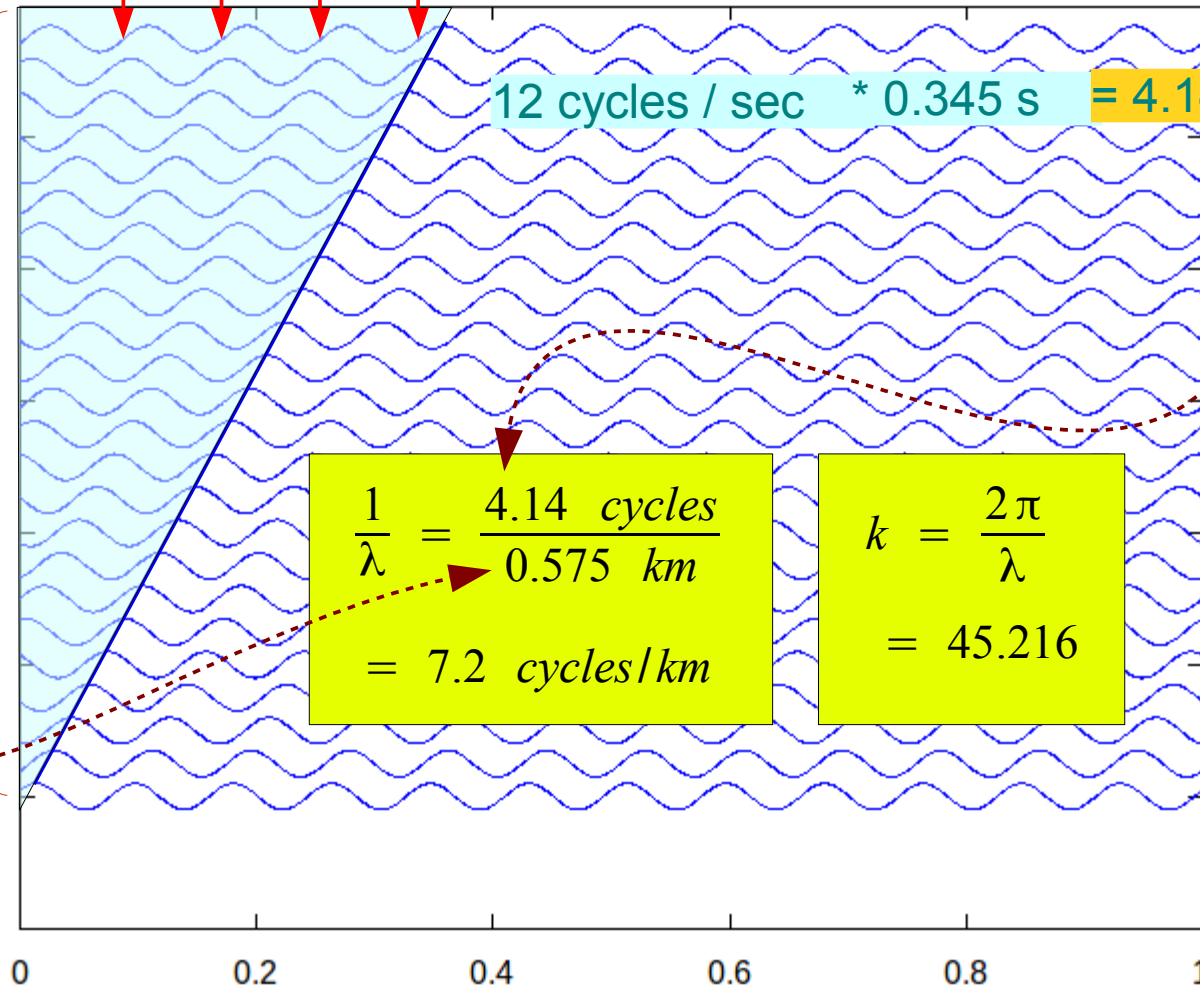
$$12 \text{ cycles / sec} * 0.345 \text{ s} = 4.14 \text{ cycles}$$

$$\frac{1}{\lambda} = \frac{4.14 \text{ cycles}}{0.575 \text{ km}}$$

$$= 7.2 \text{ cycles/km}$$

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

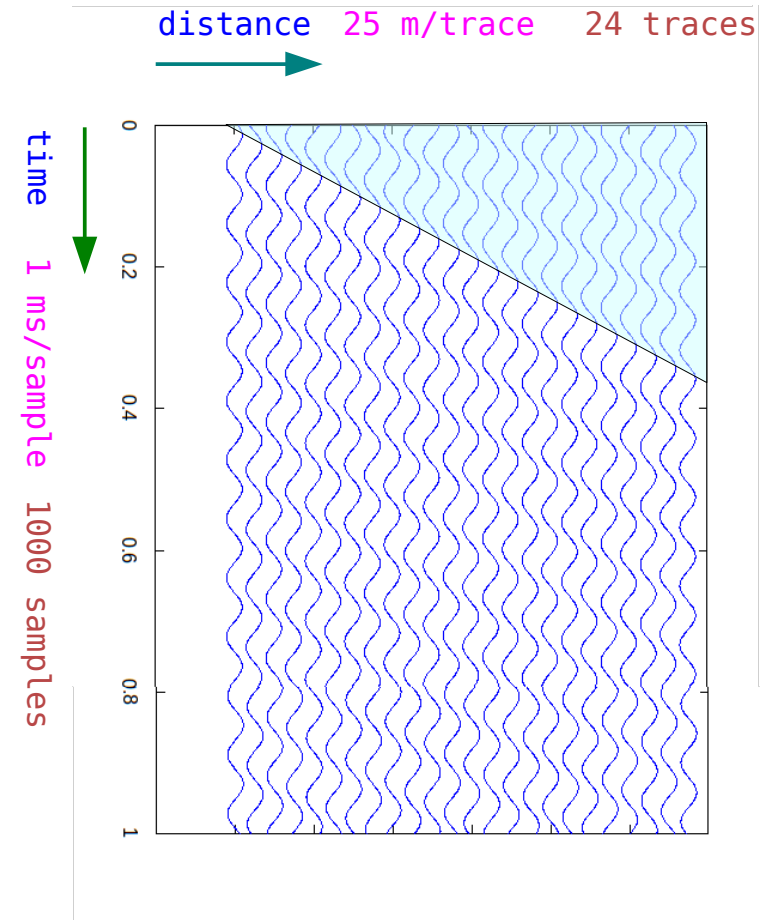
$$= 45.216$$



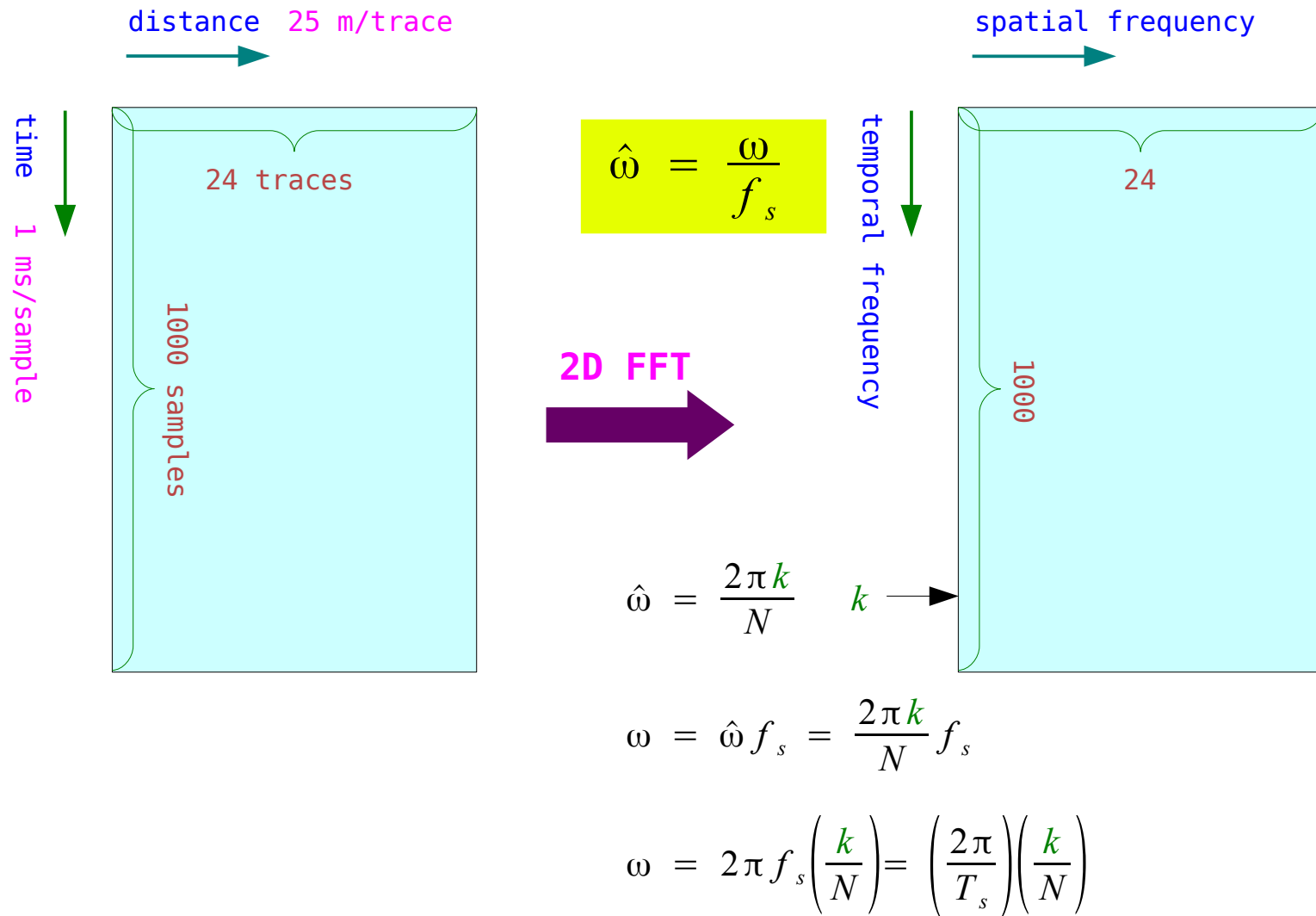
# 2D FT seismic example (4)

```
w = pi * 2.0 * 12.0; % 2 pi f
delta = 0.001; % T_s
ss = -0.015; % time delay between adjacent traces
Y = [];
time = (0:delta:1.0); % 1 sec period by T_s
m = length(time);
for i=1:24
    s = ss*(i-1);
    x = w*(time - s);
    y = cos(x);
    Y = [Y y'];
end;

Z=fft2(Y);
mag_Z = abs(Z);
ang_Z = angle(Z);
[r c] = size(Y);
tx = 1:r;
ty = 1:c;
mesh(ty, tx, mag_Z)
```

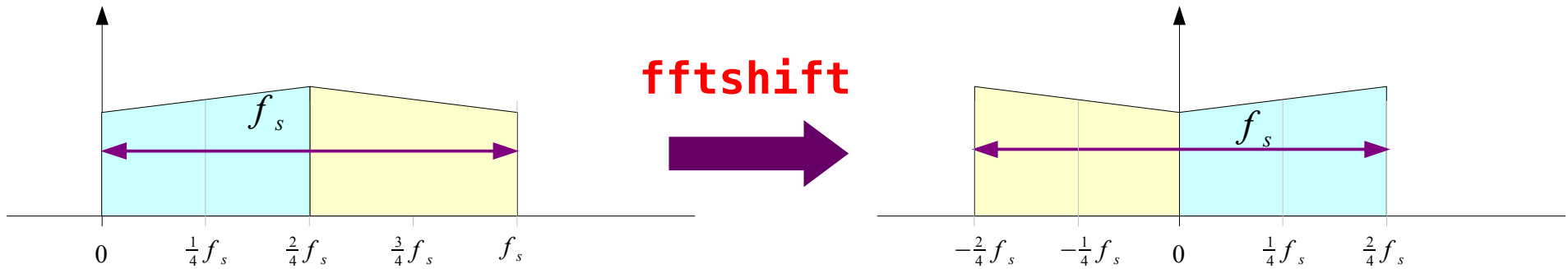


# Spatial & Temporal Frequencies (1)

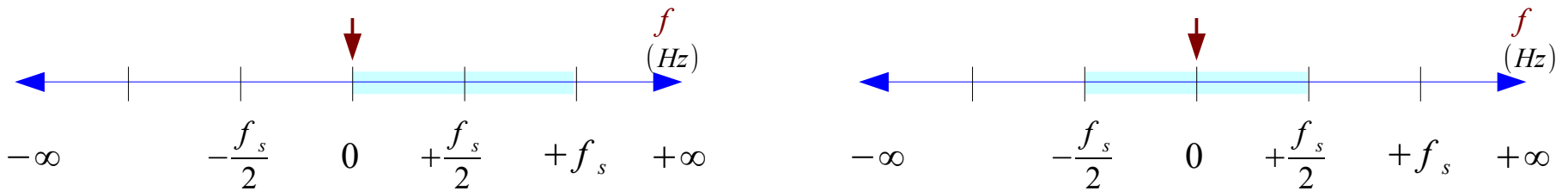




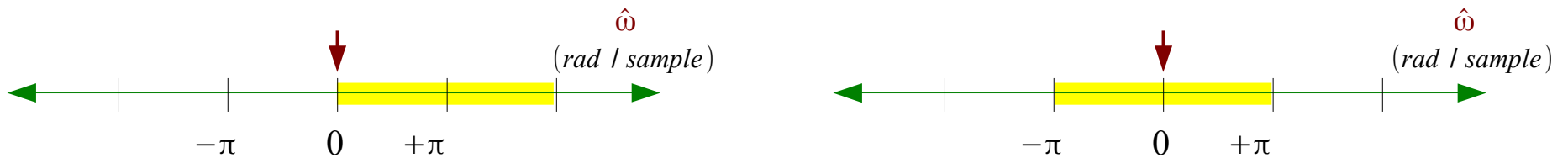
# Spatial & Temporal Frequencies (1)



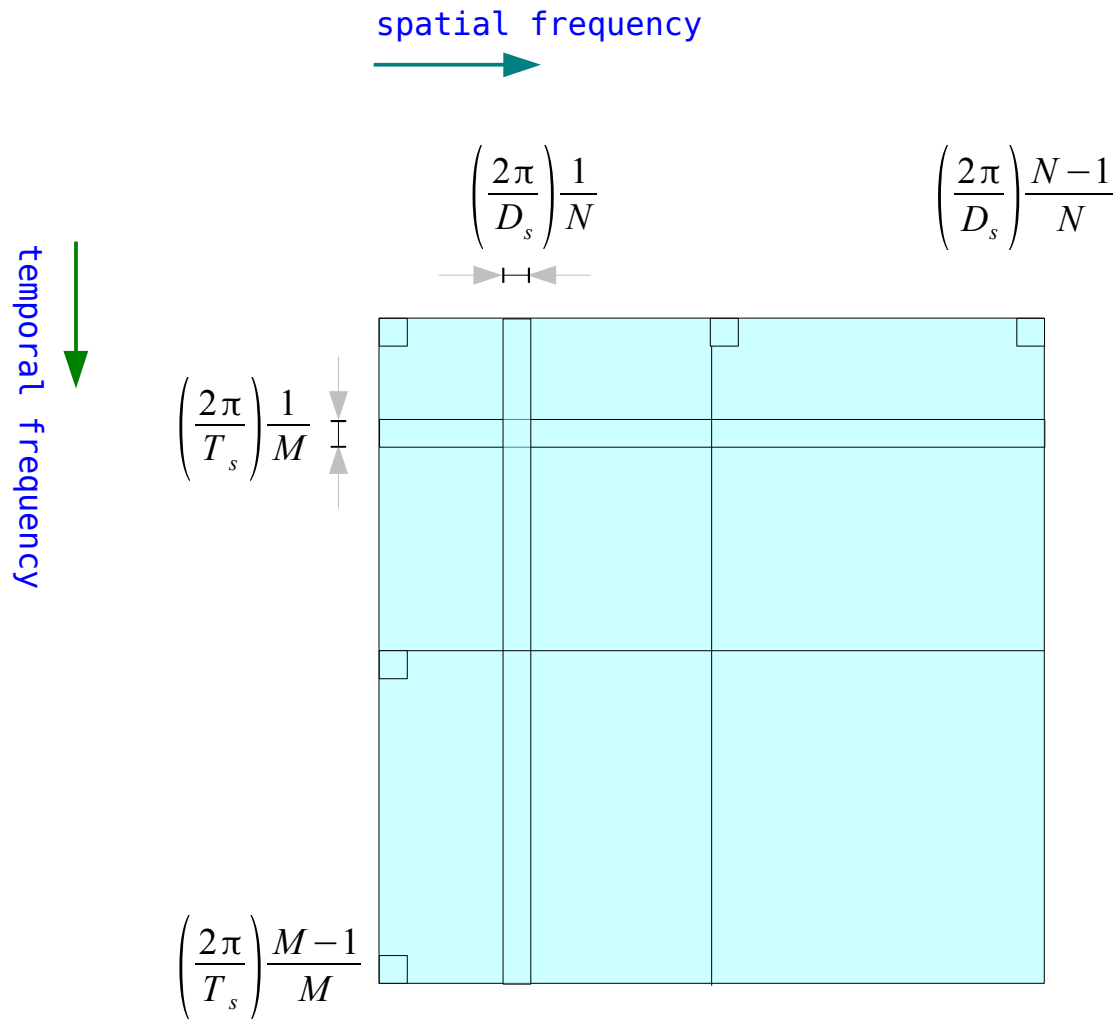
## Linear Frequency



## Normalized Radian Frequency

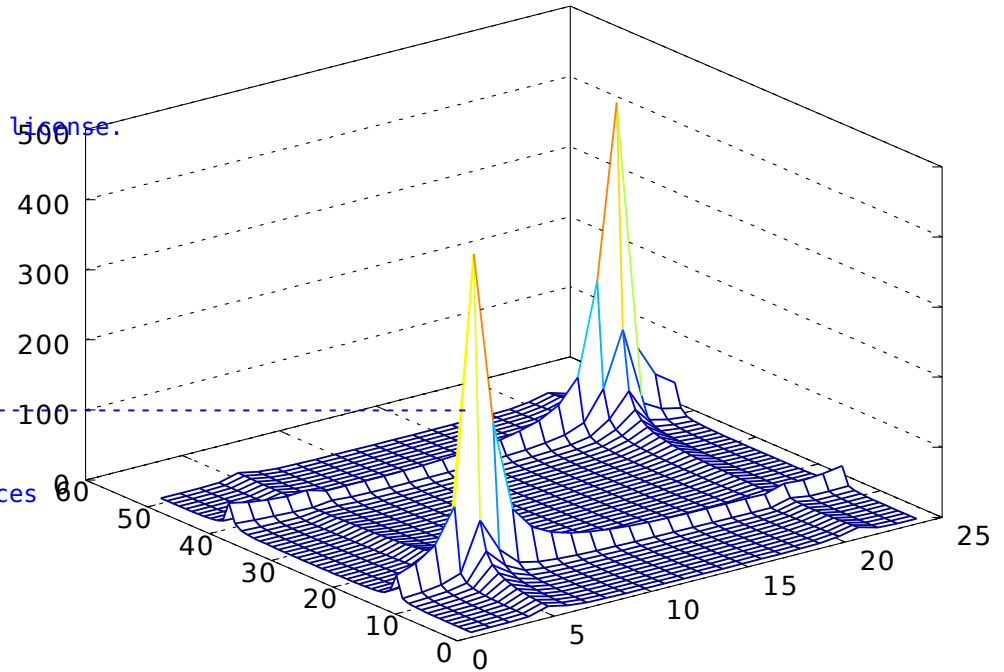


# Spatial & Temporal Frequencies (2)



# 2D FT seismic example (5)

```
-----  
%% Purpose:  
%%  
%% Plot F-k filter  
%%  
%% Discussion:  
%%  
%% Licensing:  
%%  
%% This code is distributed under the GNU LGPL License.  
%%  
%% 2012.09.22  
%%  
%% Author:  
%% Young Won Lim  
%%  
%% Parameters:  
%%  
-----  
w = pi * 2.0 * 12.0; % 2 pi f  
delta = 0.02; % T_s  
ss = -0.015; % time delay between adjacent traces  
Y = [];  
time = (0:delta:1.0); % 1 sec period by T_s  
m = length(time);  
for i=1:24  
s = ss*(i-1);  
x = w*(time - s);  
y = cos(x);  
Y = [Y y'];  
end;  
Z=fft2(Y);  
mag_Z = abs(Z);  
ang_Z = angle(Z);  
[r c] = size(Y);  
tx = 1:r;  
ty = 1:c;  
mesh(ty, tx, mag_Z)
```



$$\omega = \frac{2\pi}{T_s} \quad k = \frac{2\pi}{\lambda}$$

# 2D FT seismic example (6)

```
%%-----  
%% Purpose:  
%%  
%% Plot F-k filter  
%%  
%% Discussion:  
%%  
%% Licensing:  
%%  
%% This code is distributed under the GNU LGPL license.  
%%  
%% 2012.09.22  
%%  
%% Author:  
%%  
%% Young Won Lim  
%%  
%% Parameters:  
%%  
%%-----  
w = pi * 2.0 * 12.0; % 2 pi f  
delta = 0.02; % T_s  
ss = -0.015; % time delay between adjacent traces  
Y = [];  
time = (0:delta:1.0); % 1 sec period by T_s  
m = length(time);  
for i=1:24  
s = ss*(i-1);  
x = w*(time - s);  
y = cos(x);  
Y = [Y y'];  
end;  
Z=fft2(Y);  
mag_Z = abs(Z);  
ang_Z = angle(Z);  
[r c] = size(Y);  
tx = 1:r;  
ty = 1:c;  
mesh(ty, tx, mag_Z)
```

## References

- [1] <http://en.wikipedia.org/>
- [2] J.H. McClellan, et al., Signal Processing First, Pearson Prentice Hall, 2003
- [3] <http://www.mathpages.com/>, Phase, Group, and Signal Velocity
- [4] R. Barlow, [www.hep.man.ac.uk/u/roger/PHYS10302/lecture15.pdf](http://www.hep.man.ac.uk/u/roger/PHYS10302/lecture15.pdf)
- [5] P. Hofmann, [www.philiphofmann.net/book\\_material/notes/groupphasevelocity.pdf](http://www.philiphofmann.net/book_material/notes/groupphasevelocity.pdf)
- [6] <http://www.ualberta.ca/~ygu/courses/geoph426/>