Timelockanalysis

- Command: ft_definetrial, ft_preprocessing, ft_timelockanalysis, ft_megplanar, ft_combineplanar, ft_singleplotER, ft_multiplotER, ft_topoplotER

Task:
- Follow the script in timelockanalysis
- http://www.fieldtriptoolbox.org/tutorial/eventrelatedaveraging
- You might add the step of reject visual
- Calculate planar gradiometers
- Plot the results
- Compare topography of planar and axial gradiometers

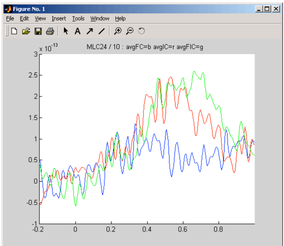
Timelockanalysis

- Command: ft_redefinetrial, ft_preprocessing, ft_timelockanalysis, ft_megplanar, ft_combineplanar, ft_singleplotER, ft_multiplotER, ft_topoplotER

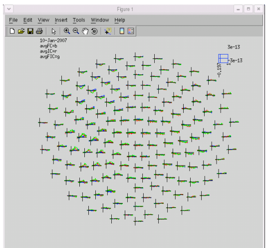
Task:
- Do the timelockanalysis for dataset 04_Inhibition_20150507_14.ds for d2 and d3 single stimulation, with maximal intensity.
- Use artifact rejection.
- Use both planar and axial gradiometers.

Plotting

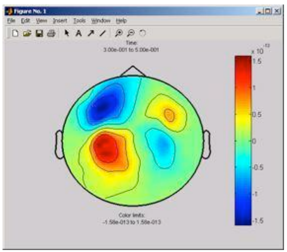
- Command: *ft_singleplotER, ft_multiplotER, ft_topoplotER, ft_singleplotTFR, ft_multiplotTFR, ft_topoplotTFR, ft_clusterplot*



ft_singleplotER



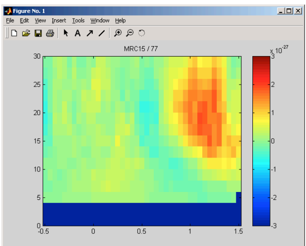
ft_multiplotER



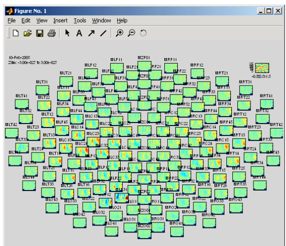
ft_topoplotER

Plotting

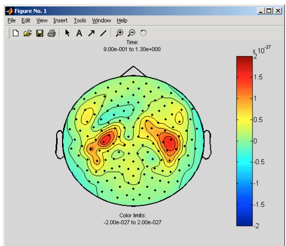
- Command: *ft_singleplotER, ft_multiplotER, ft_topoplotER, ft_singleplotTFR, ft_multiplotTFR, ft_topoplotTFR, ft_clusterplot*



ft_singleplotTFR



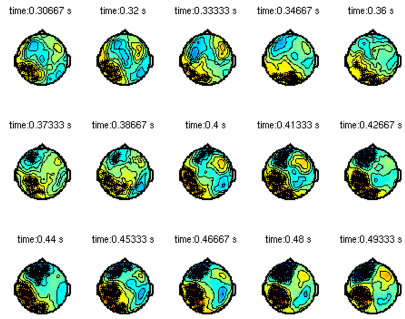
ft_multiplotTFR



ft_topoplotTFR

Plotting

- Command: *ft_singleplotER, ft_multiplotER, ft_topoplotER, ft_singleplotTFR, ft_multiplotTFR, ft_topoplotTFR, ft_clusterplot*



ft_clusterplot

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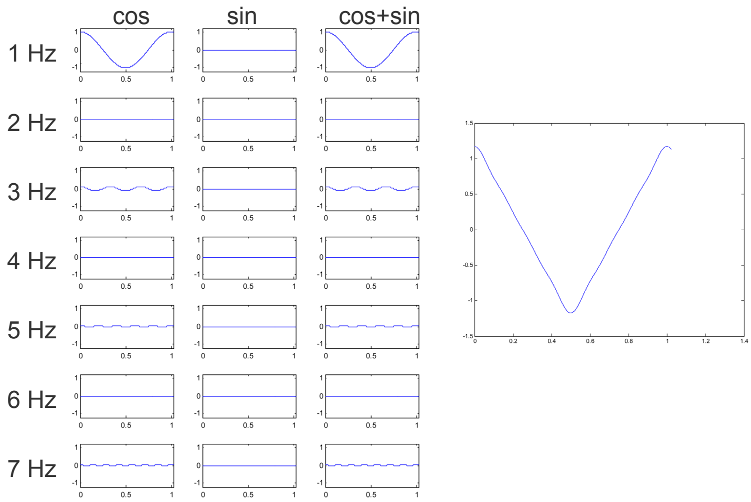
Spectral Analysis



Spectral Analysis

Music is composed of different frequencies.

Using filters and spectral analysis (Fourier transform) the contributing components can be identified.

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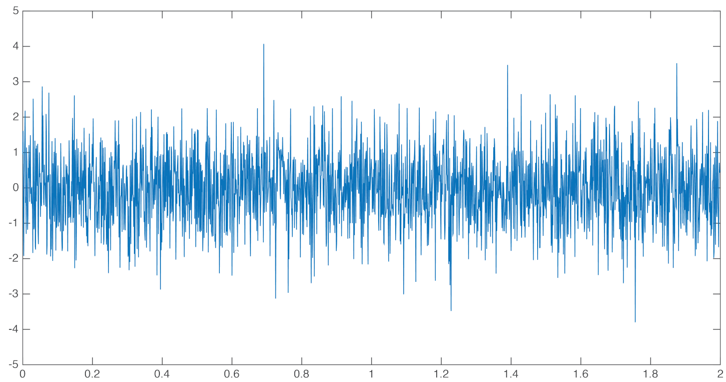
Spectrum

```
d=randn(2000,1);
t=[0:size(d,1)-1]*0.001;
plot (t,d,'FontSize',16);
ylim([-5 5])
```



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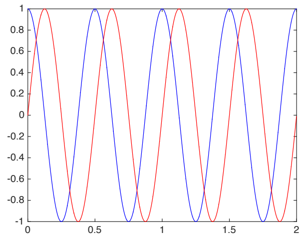
Spectrum

Fourier decomposition any signal can be decomposed in a series of cosine and sine waves with different weights (fourier coefficients)

$$d(t) = A_o + \sum_n A_i \cos(2\pi nft) + \sum_n B_i \sin(2\pi nft) \quad \text{with} \quad f = \frac{1}{T}$$




```
figure
plot(t,cos(2*pi*2*t),'b')
hold on
plot(t,sin(2*pi*2*t),'r')
ax=gca
ax.FontSize=16;
```

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Spectrum

What will happen if you try out the following series

$$A_n = 0 \qquad B_n = \begin{cases} \frac{1}{n}, & n \text{ is odd} \\ 0, & n \text{ is even} \end{cases}$$

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Spectrum

What will happen if you try out the following series

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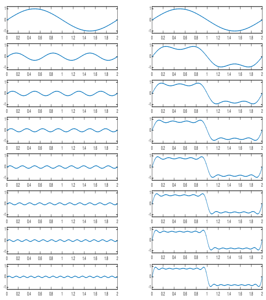

```
x=[0:0.001:2];
f=1/x(end);
y=zeros(size(x));
m=15
for n=1:2:m
    y_tmp=sin(2*pi*n*f*x)/n;
    y=y+y_tmp
    subplot((m+1)/2,2,n)
    plot(x,y_tmp)
    ylim([-1.2,1.2]);
    subplot((m+1)/2,2,n+1)
    plot(x,y)
    ylim([-1.2,1.2]);
end
```

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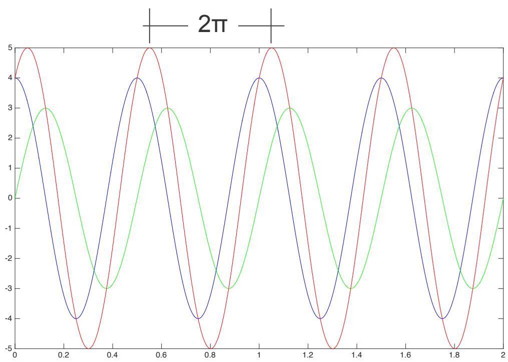
Spectrum: Complex representations

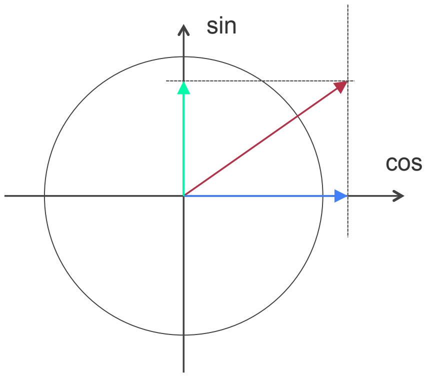
What will happen if you try out the following series




```
t=[0:0.001:2];
a=4*cos(2*pi*2*t)
b=3*sin(2*pi*2*t)
plot(t,a,'b')
hold on
plot(t,b,'g')
plot(t,a+b,'r');
ax=gca;
ax.FontSize=16
```

Spectrum: Complex representations

What will happen if you try out the following series




```
t=[0:0.001:2];
f=1/x(end);
y=zeros(size(x));
m=15
for n=1:2:m
    y_tmp=sin(2*pi*n*f*x)/n;
    y=y+y_tmp
    subplot((m+1)/2,2,n)
    plot(x,y_tmp)
    ylim([-1.2,1.2]);
    subplot((m+1)/2,2,n+1)
    plot(x,y)
    ylim([-1.2,1.2]);
end
```


Time-Frequency Analysis

Video

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Time-Frequency Analysis

ft_freqanalysis

ft_freqanalysis performs frequency and time-frequency analysis on time series data over multiple trials

cfg.method = different methods of calculating the spectra

- **'mtmfft'**, analyses an entire spectrum for the entire data length, implements multitaper frequency transformation
- **'mtmconvol'**, implements multitaper time-frequency transformation based on multiplication in the frequency domain.
- **'wavelet'**, implements wavelet time frequency transformation (using Morlet wavelets) based on multiplication in the frequency domain.
- **'tfr'**, implements wavelet time frequency transformation (using Morlet wavelets) based on convolution in the time domain.
- **'mvar'**, does a fourier transform on the coefficients of an estimated multivariate autoregressive model, obtained with FT_MVARANALYSIS. In this case, the output will contain a spectral transfer matrix, the cross-spectral density matrix, and the covariance matrix of the innovation noise.

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Time-Frequency Analysis

- Command: *ft_freqanalysis*

Task:
- Tutorial: Time-frequency analysis (http://www.fieldtriptoolbox.org/tutorial/timefrequencyanalysis)
- Use dataset Subject01
- Try different methods and compare the results

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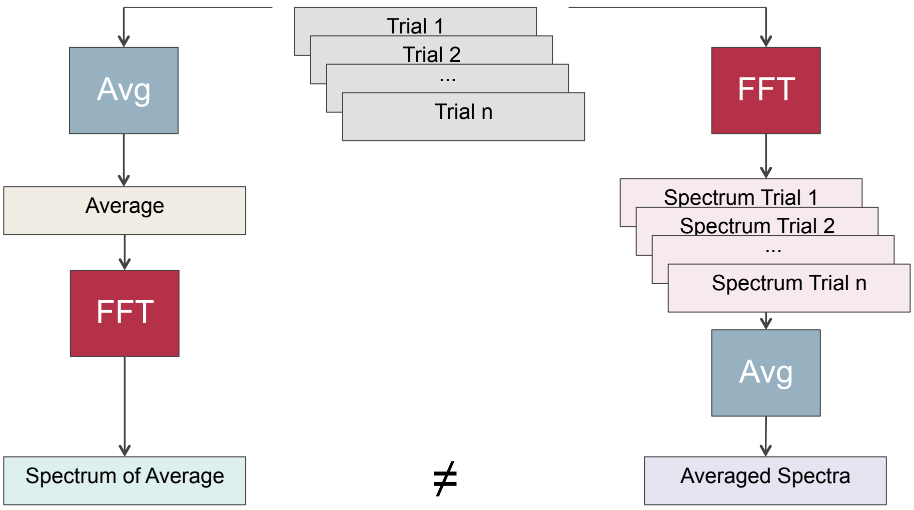
Evoked and induced responses



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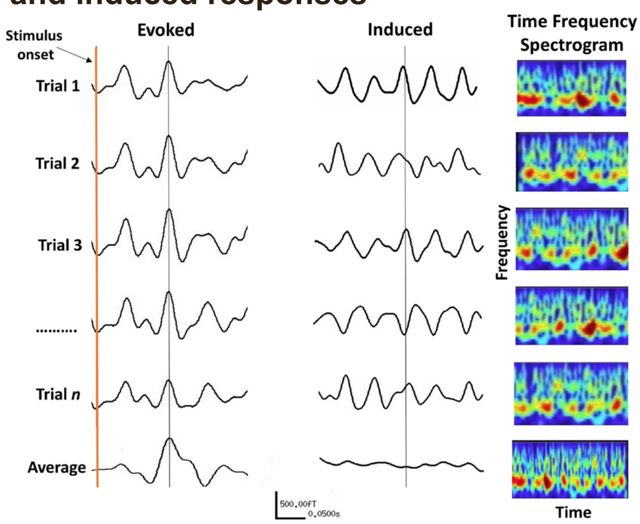
Evoked and induced responses



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Spectrum: Complex representations

If cosine and sine wave are combined the complex representation gives an easy interpretation:

$$\alpha + i\beta = ae^{i\varphi}$$
$$= \sqrt{\alpha^2 + \beta^2}\, e^{i\varphi}$$

$$\varphi = \arctan\left(\frac{\beta}{\alpha}\right)$$

It holds that: $$e^{i\varphi} = \cos(\varphi) + i\sin(\varphi)$$