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Photoplethysmographic blood presure measurement

Peňáz´s method, volume-clamp method

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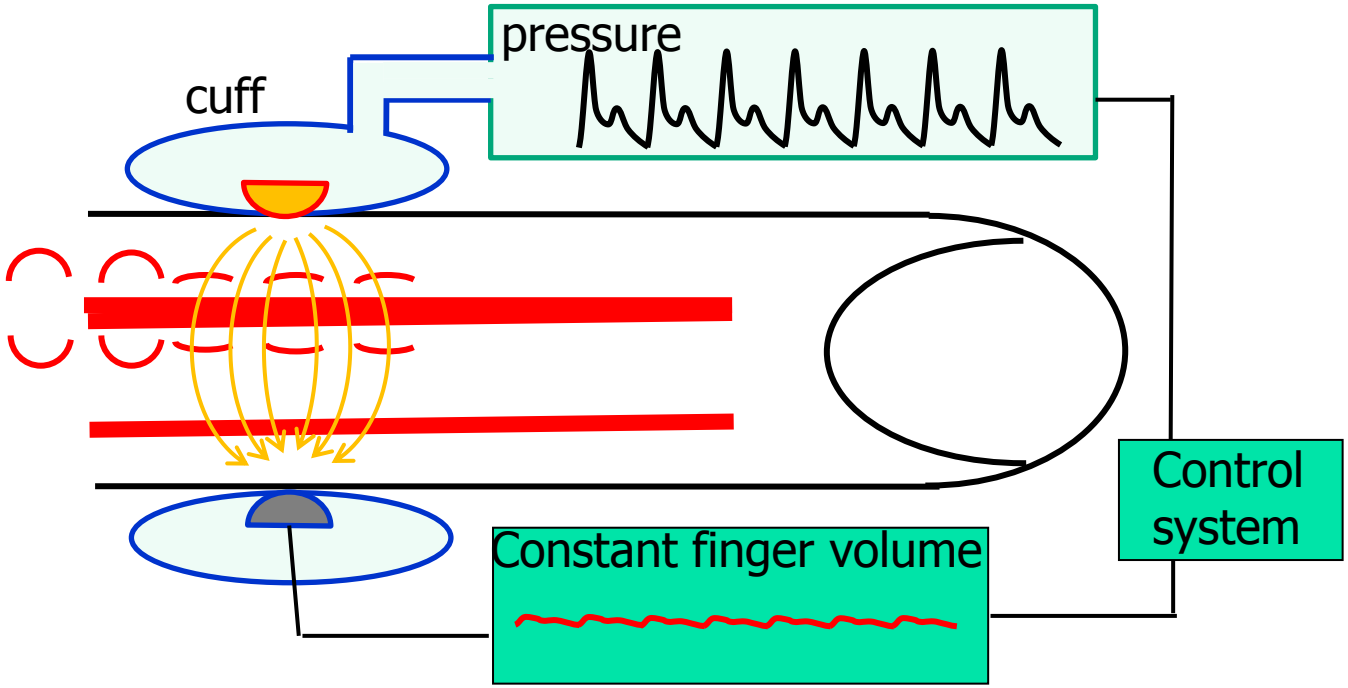
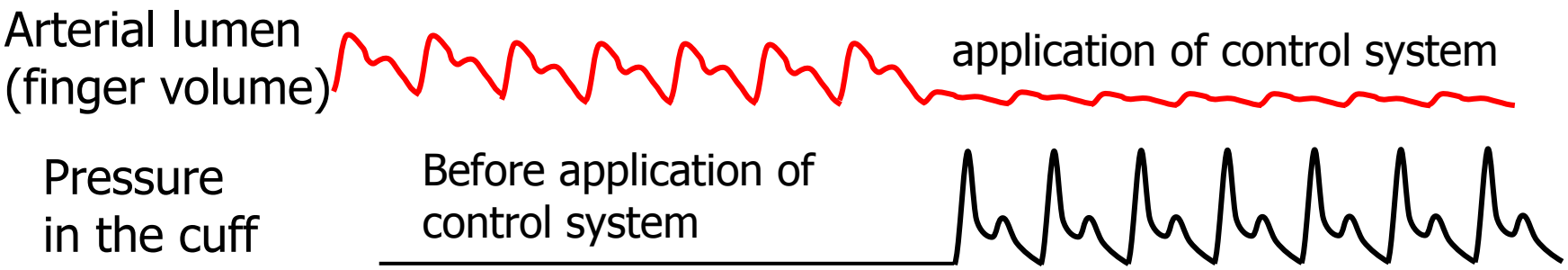
Principle of continual blood pressure measurement

Control system:
Correction of the pressure in the finger cuff according to the arterial lumen changes.
Aim: maintaining of constant arterial lumen through pressure changes in the cuff.





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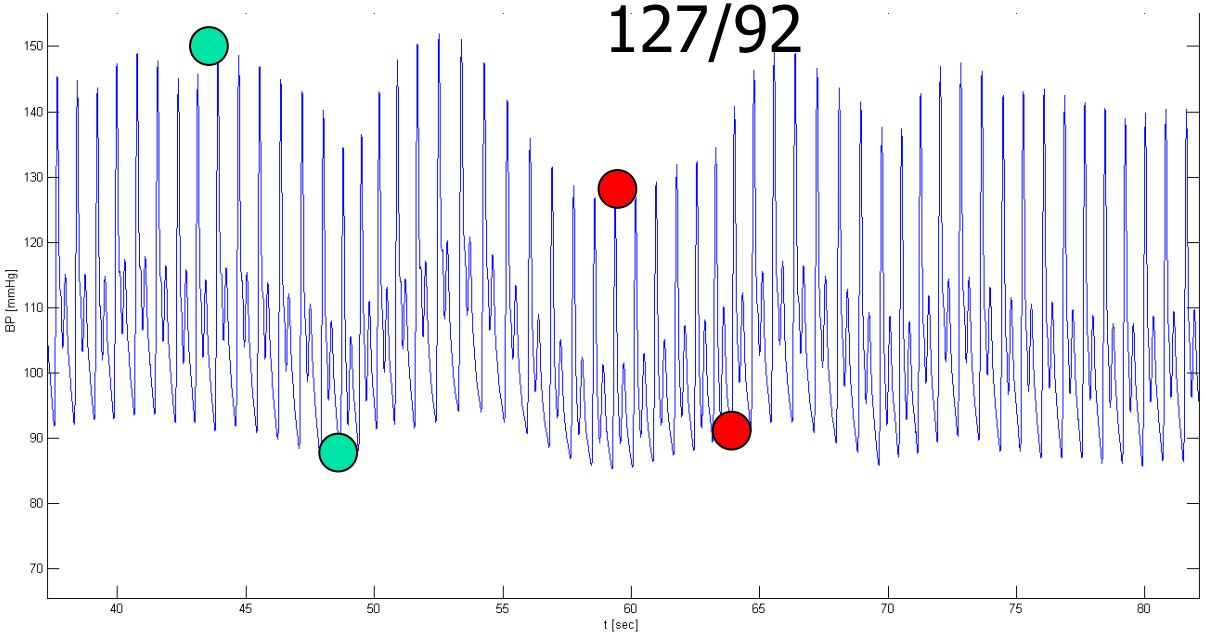
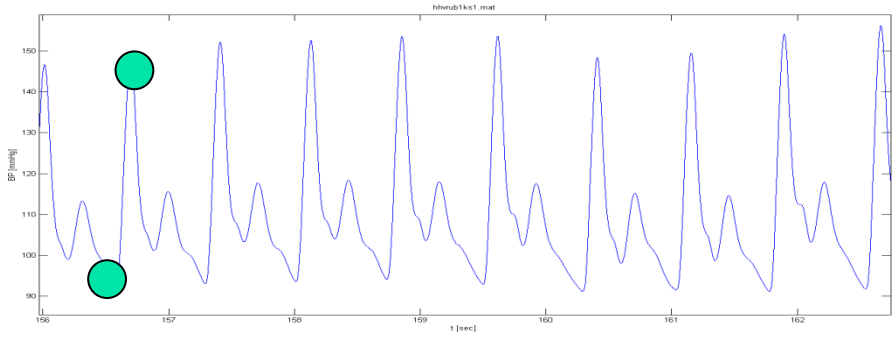
150/90

127/92



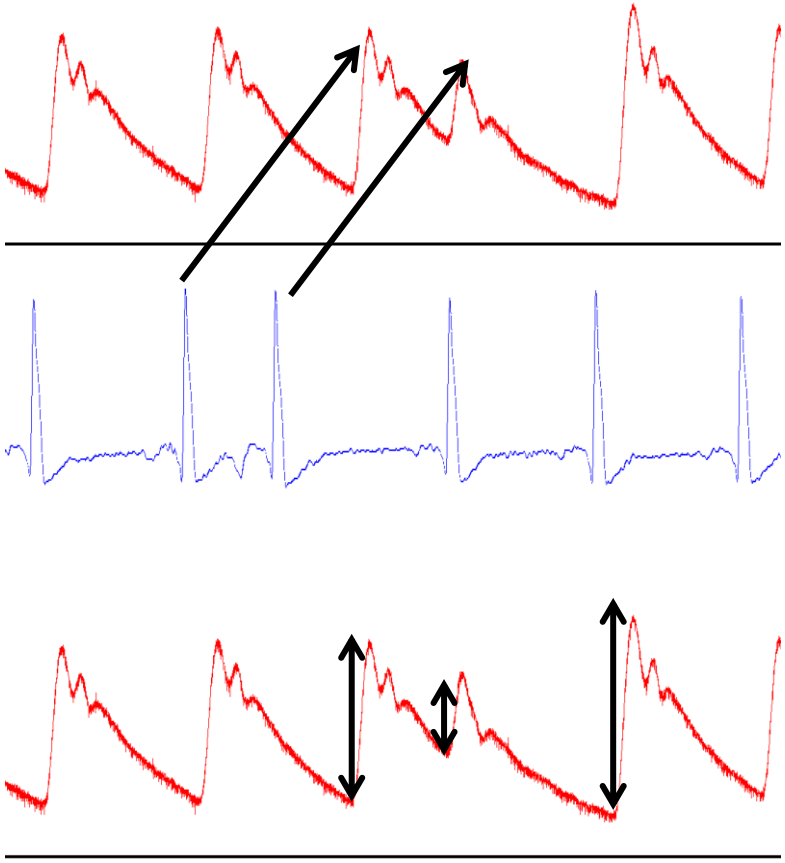
SBP



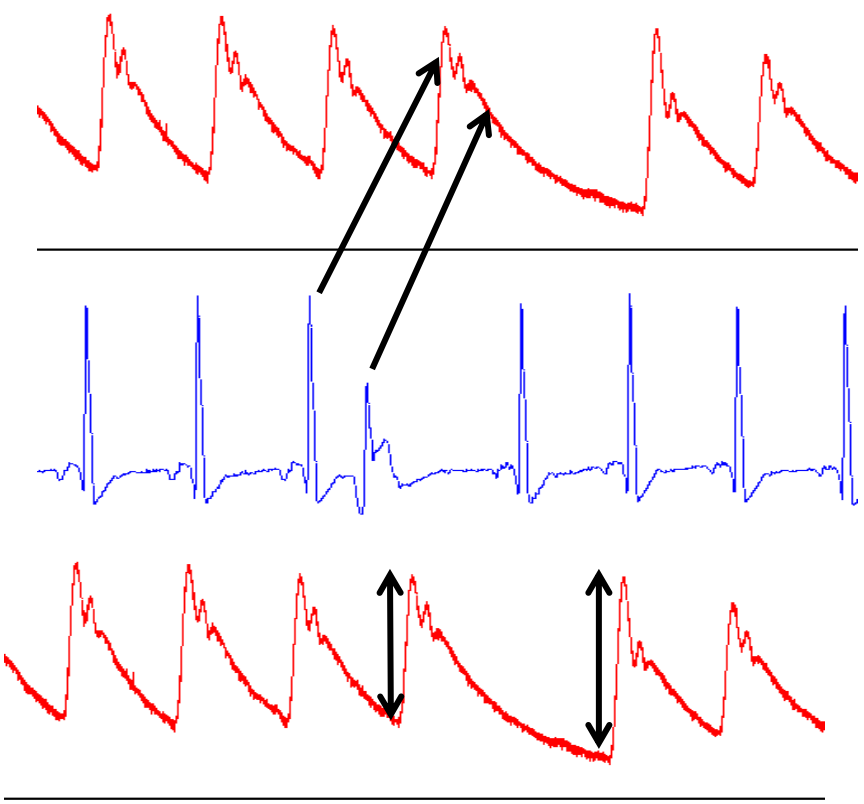
DBP

Extrasystoles

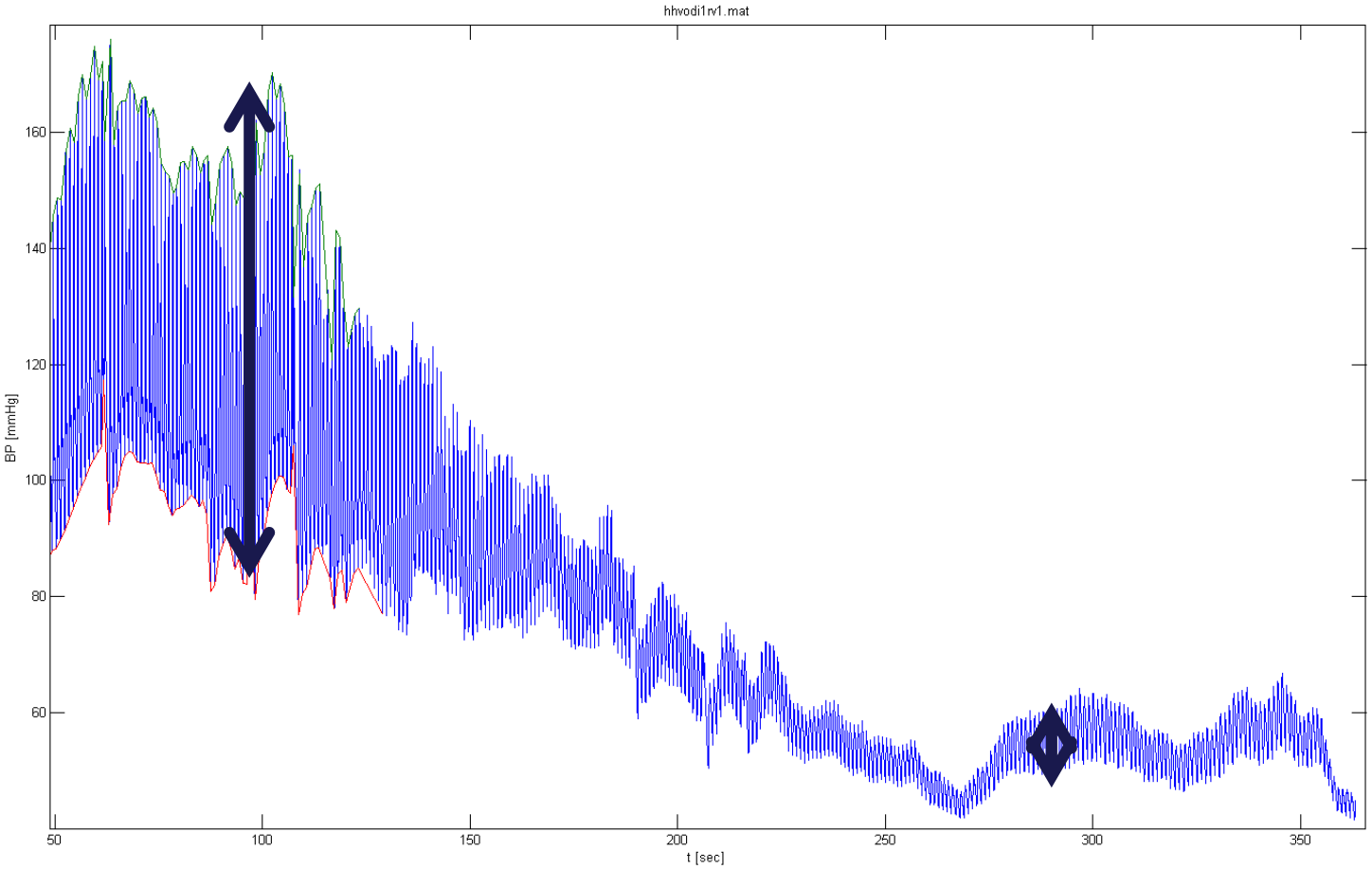
supraventricular



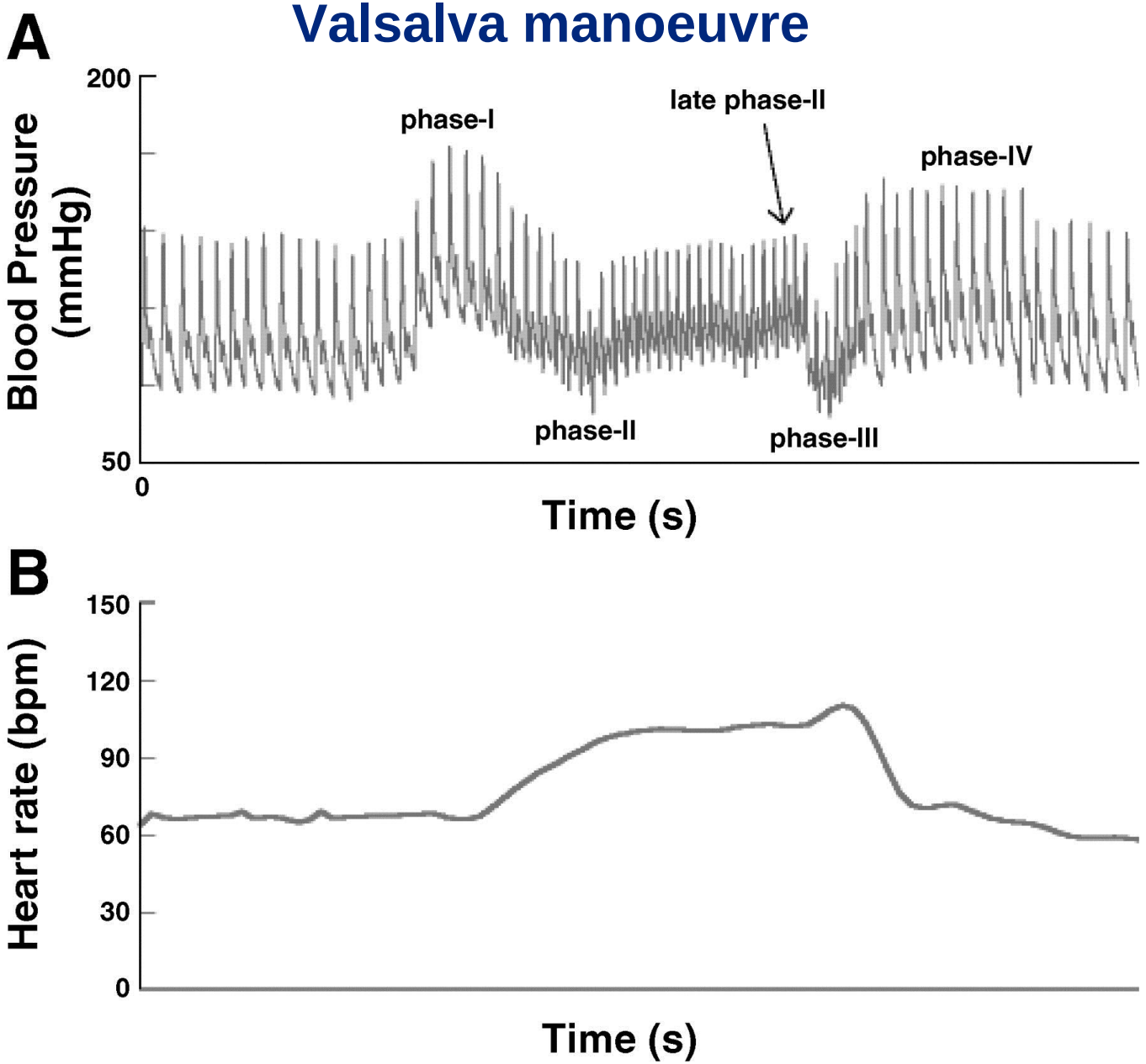
ventricular



Orthostatic hypotension



Valsalva manoeuvre



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See videos:

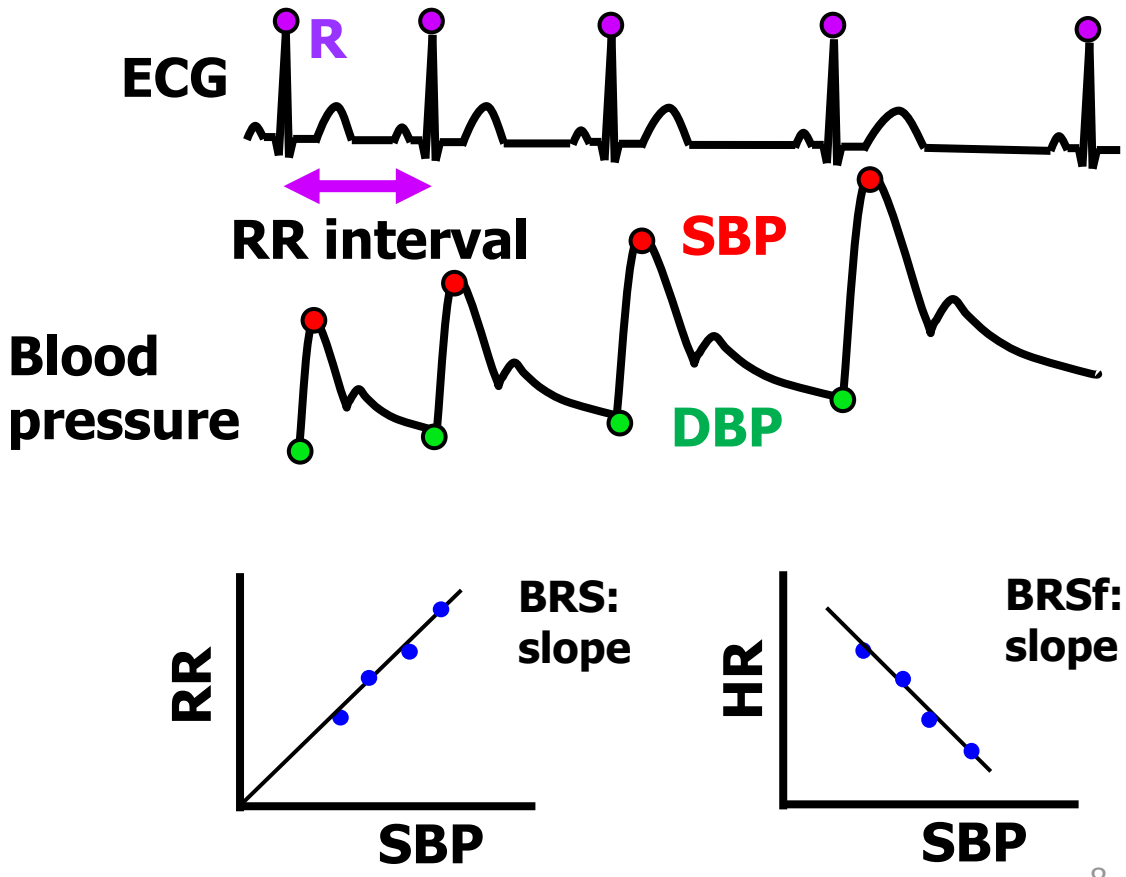
oscilometric method of BP measurement
https://www.youtube.com/watch?v=Y-NvovSaWTc&t=113s

BP changes during smoking
https://www.youtube.com/watch?v=J5vPJPfNH3k&t=1s

Baroreflex sensitivity, BRS

Evaluation of cardiac baroreflex function through SBP and heart rate (cardiac cycle) changes

BRS: change of cardiac cycle caused by SBP change by 1 mmHg [ms/mmHg]



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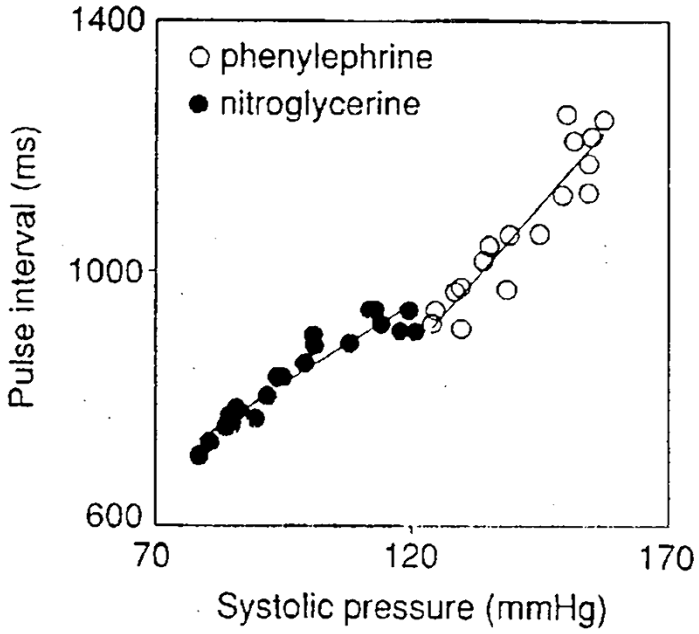
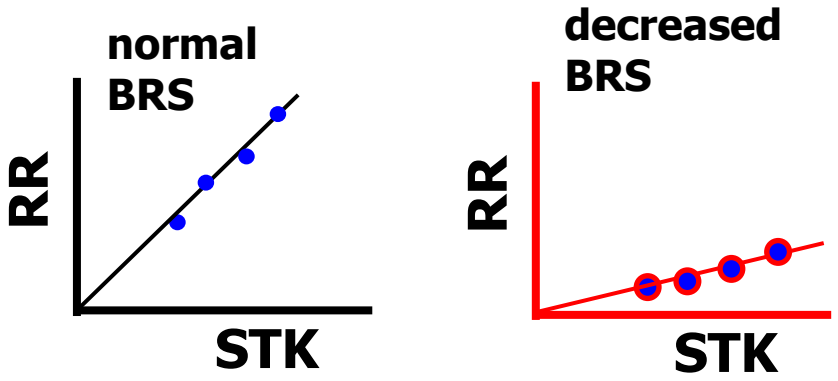
Evaluation of BRS

Standard(oxford) method:

- Application of phenylephrine (vasoconstrictor)

Bolus injections of vasoactive drugs





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Decreased BRS

- Physiologically
  - psychic stress – increased sympathetic activity
  - Physical exercise – increased sympathetic activity
  - In old age

- Pathologically
  - hypertension – decreased baroreceptor sensitivity (atherosclerosis, increased arterial stiffness)
  - diabetes – neuropathy of autonomic nervous system
  - Chronic depression (neurogenic)
  - Heart insufficiency/failure – heart do not response
  - Transplanted heart - denervation
  - Myocardial infarction – heart do not response







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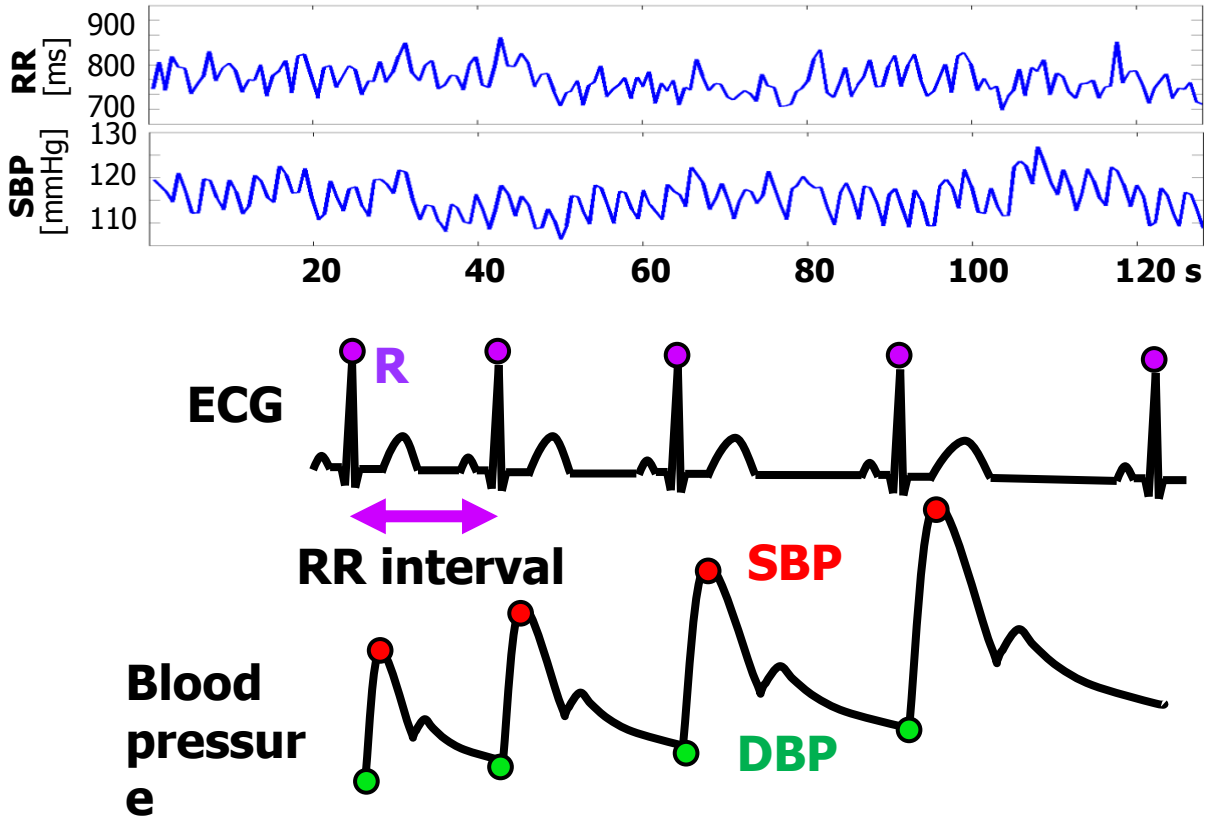
Signal: time series

Beat to beat (for example 5 minutes)

- RR interval: 805, 820, 815, 817, 822, 816,..... ms
- Hear rate: 70, 73, 68, 65, 67, 71,..... bpm
- Systolic blood pressure: 115, 117, 120, 116, 121, 119,..... mmHg



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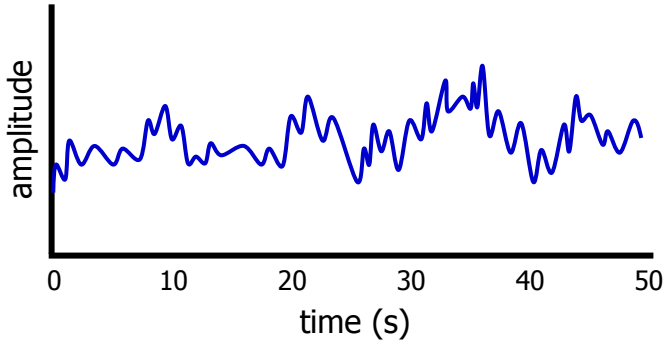
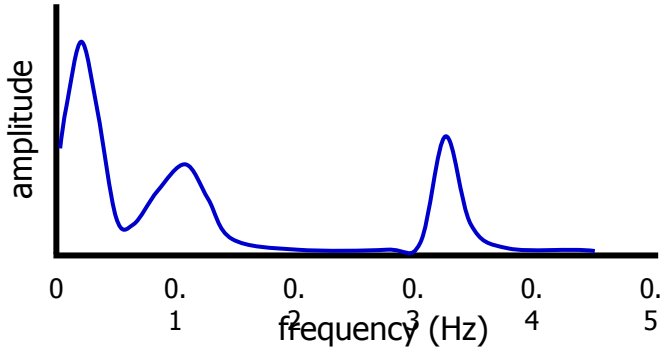
Frequency domain methods – spectral analysis

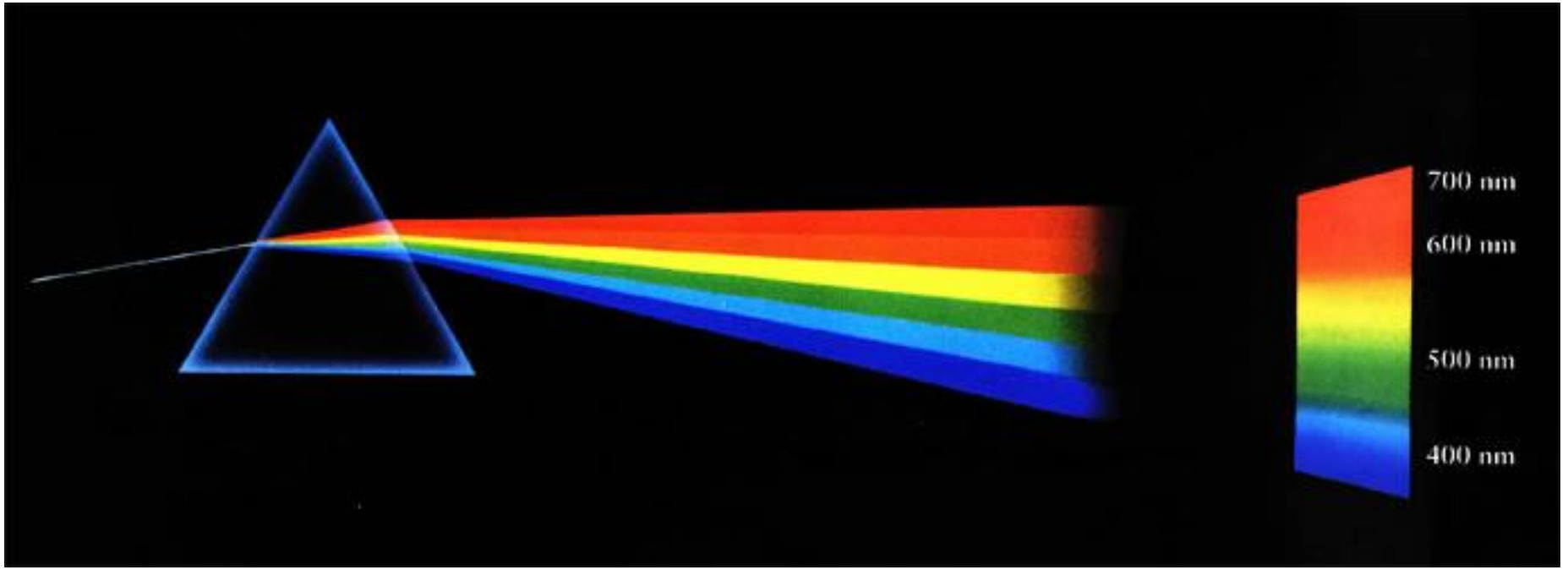
Time series
Signal in time domain

Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies







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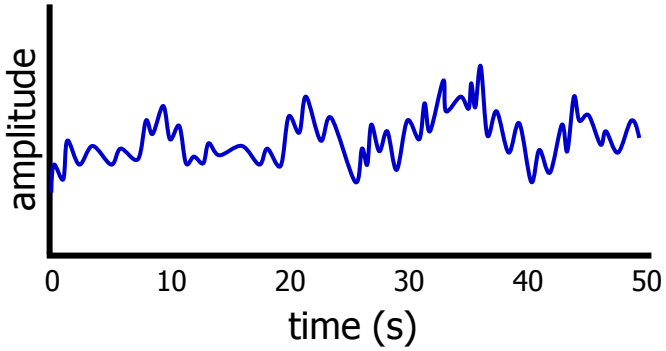
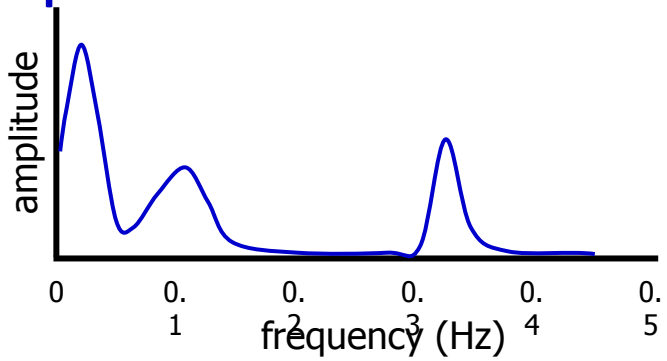
Frequency domain methods – spectral analysis

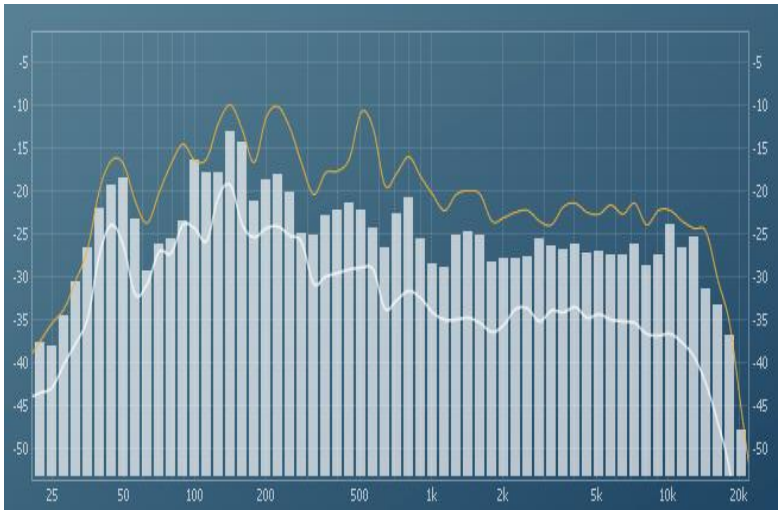
Time series
Signal in time domain

Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies







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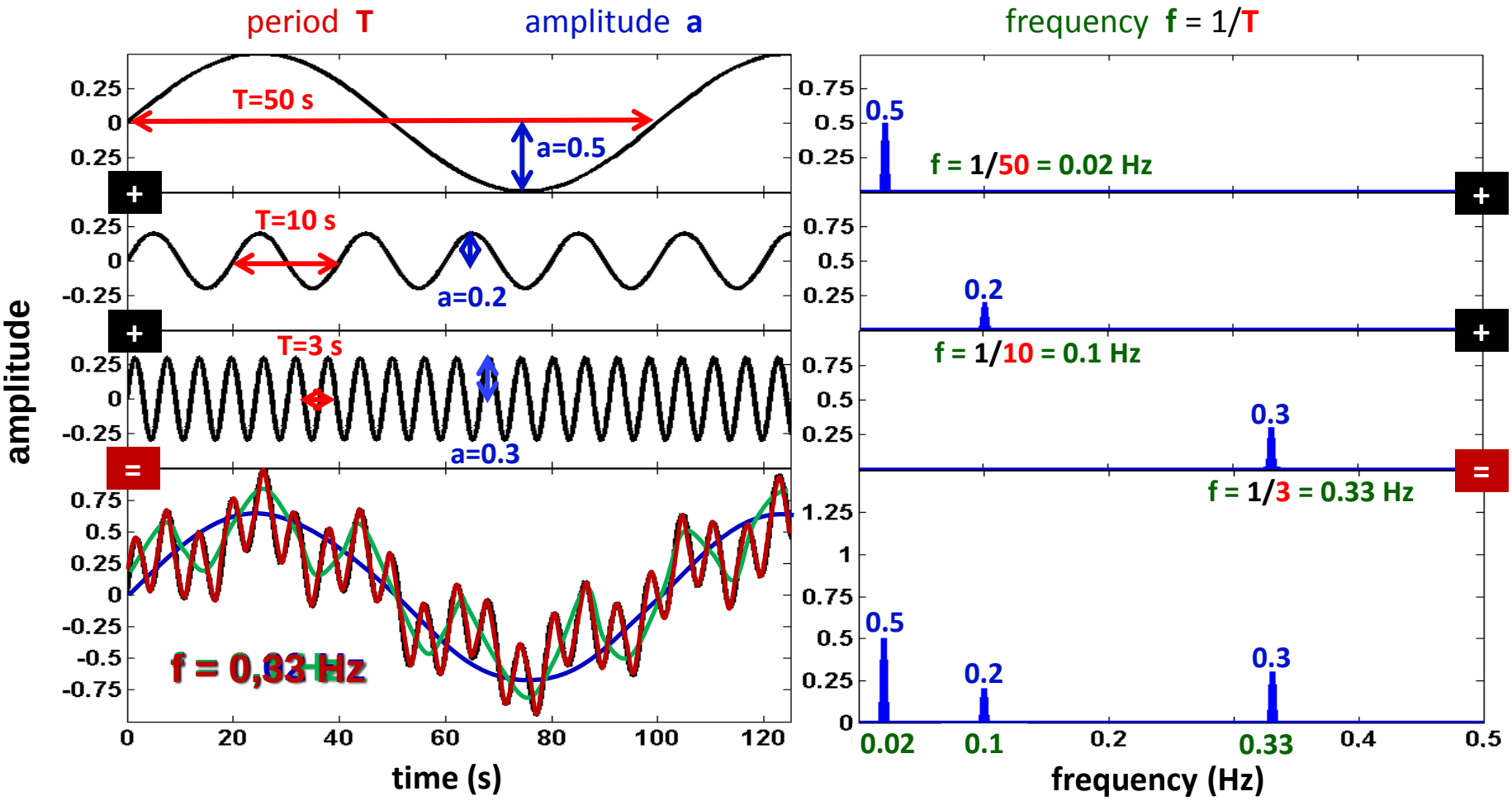
How the spectrum is formed?

Time domain

Spectrum
Frequency domain



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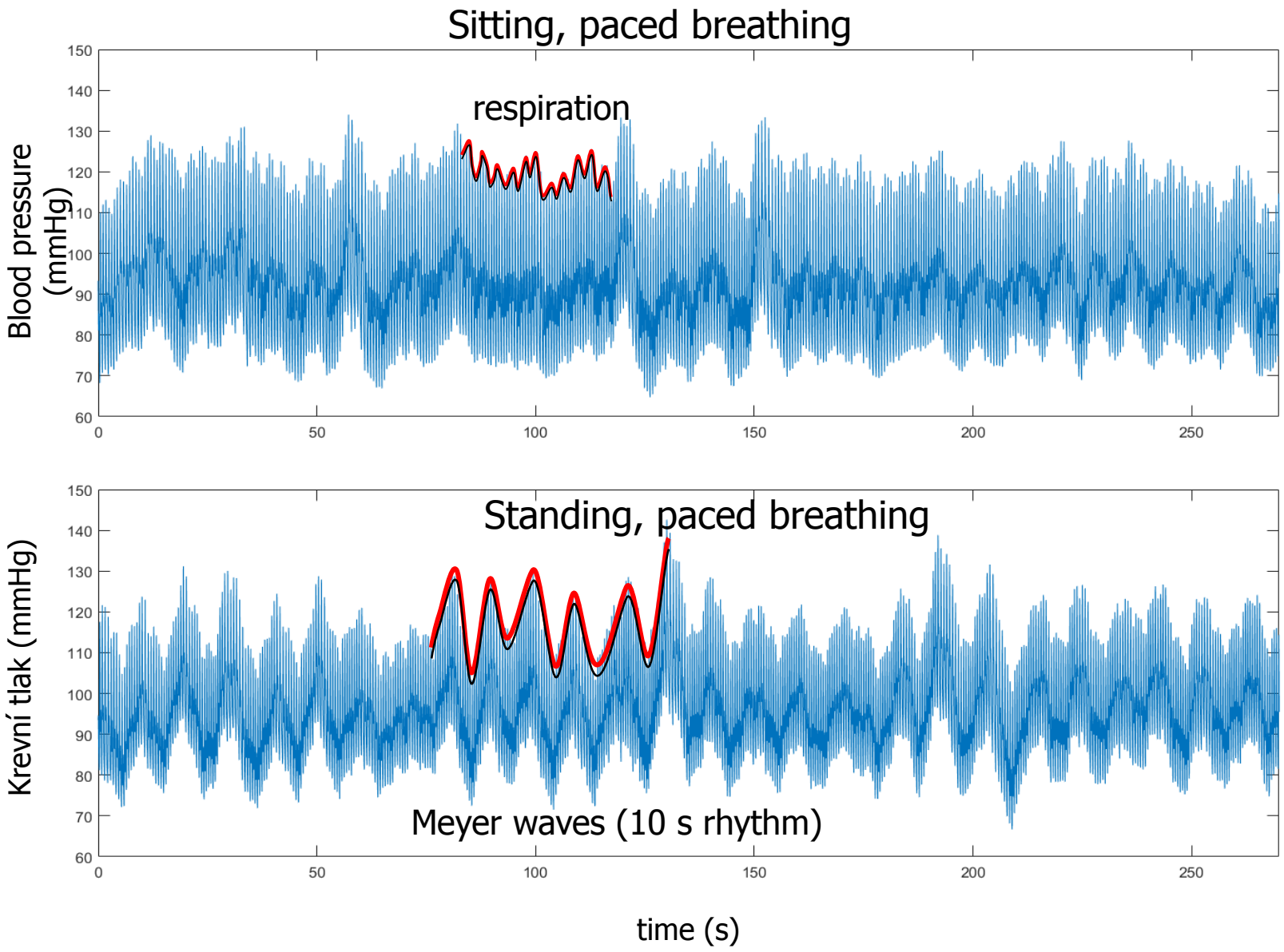
Blood pressure signal (270 s)



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sequentions of SBP, DBP and inter-beat intervals

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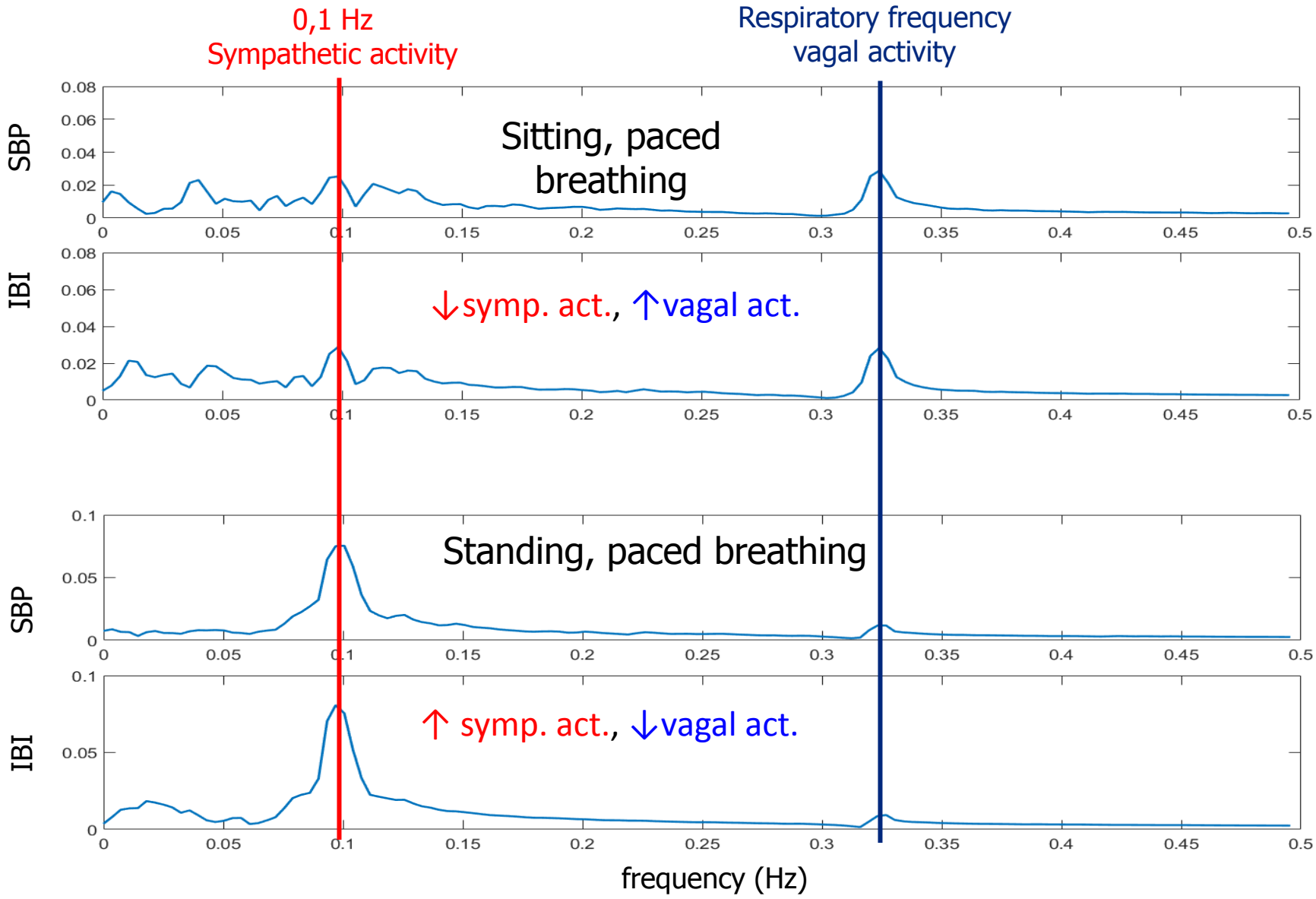
Spectra of SBP and IBI



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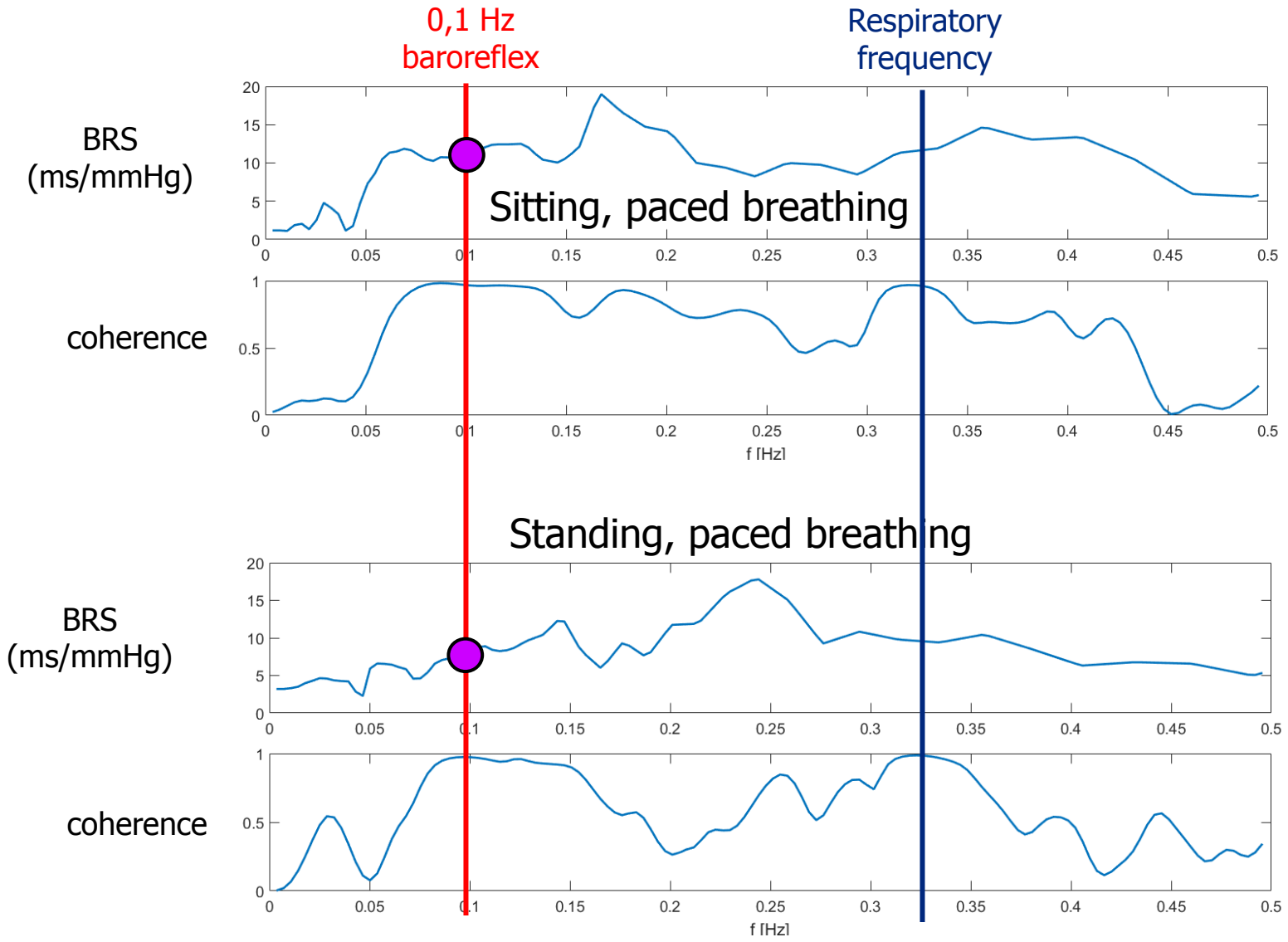
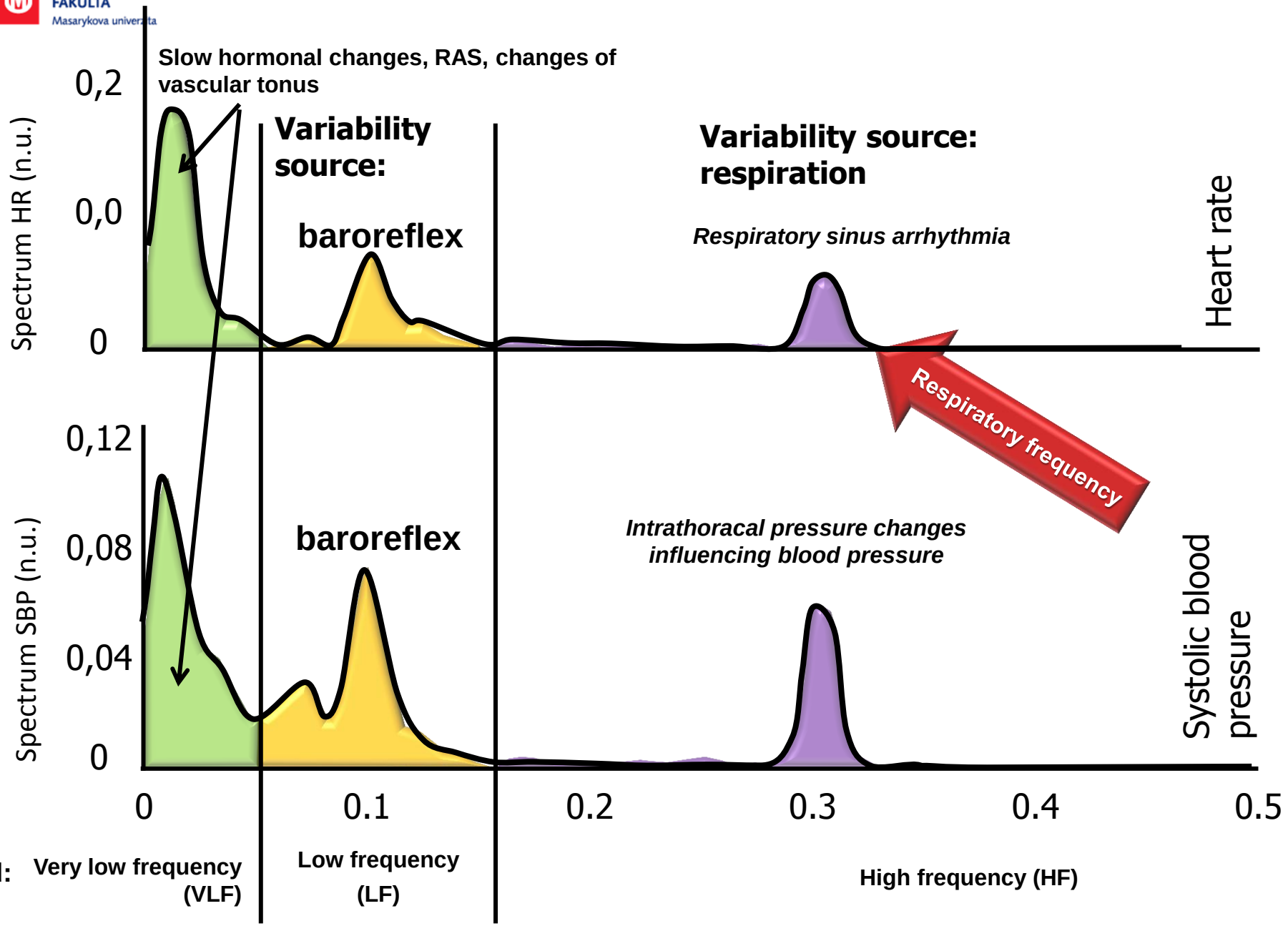
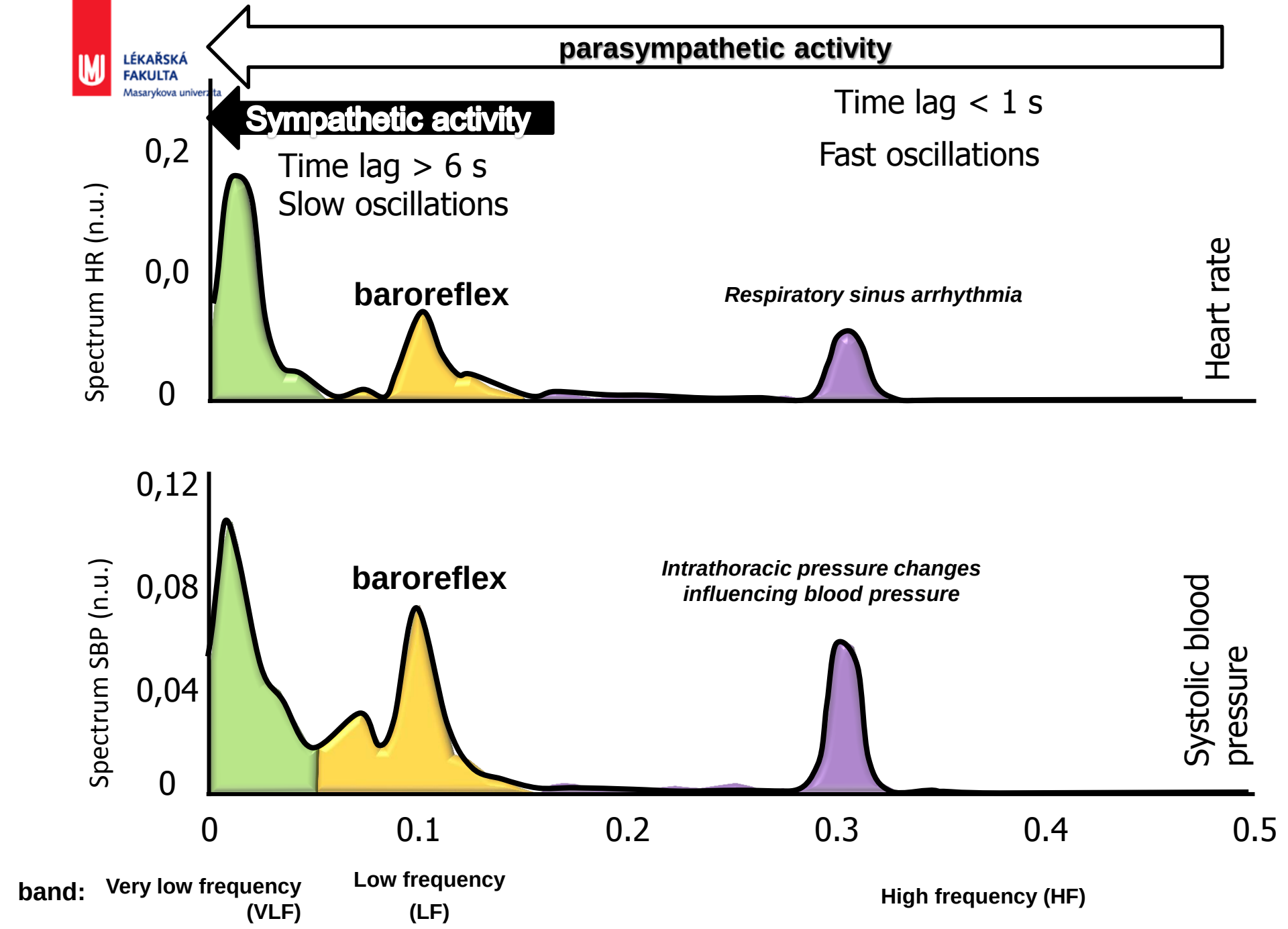
Coherence a BRS

coherence: synchronization between signals (correlation on particular frequency)



Physiological significance – frequency bands

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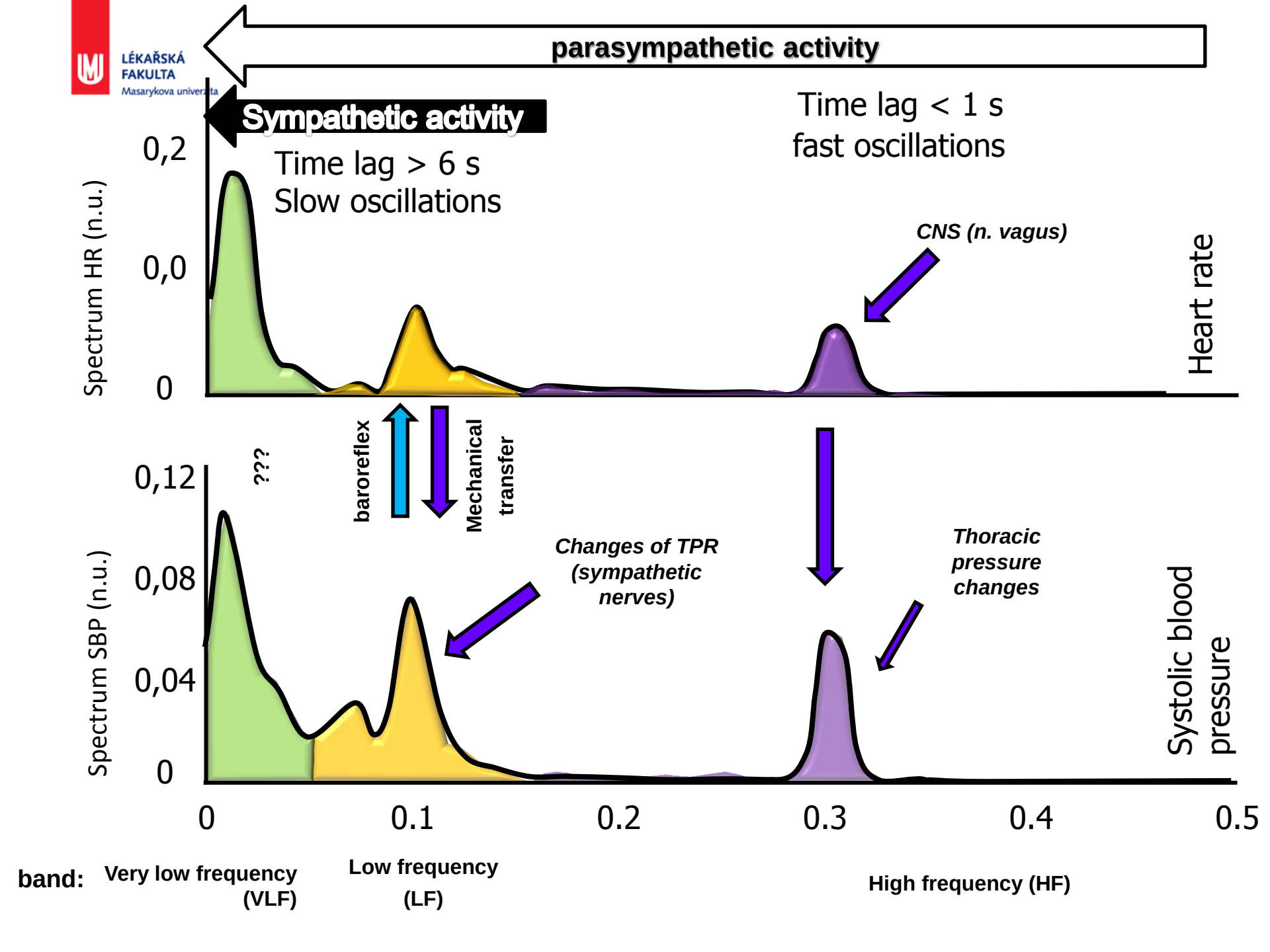
parasympathetic activity
Sympathetic activity
Time lag < 1 s
Fast oscillations
Time lag > 6 s
Slow oscillations
0,2
0,0
0
Spectrum HR (n.u.)
baroreflex
Respiratory sinus arrhythmia
Heart rate
0,12
0,08
0,04
0
Spectrum SBP (n.u.)
baroreflex
Intrathoracic pressure changes influencing blood pressure
Systolic blood pressure
0
0.1
0.2
0.3
0.4
0.5
band:
Very low frequency (VLF)
Low frequency (LF)
High frequency (HF)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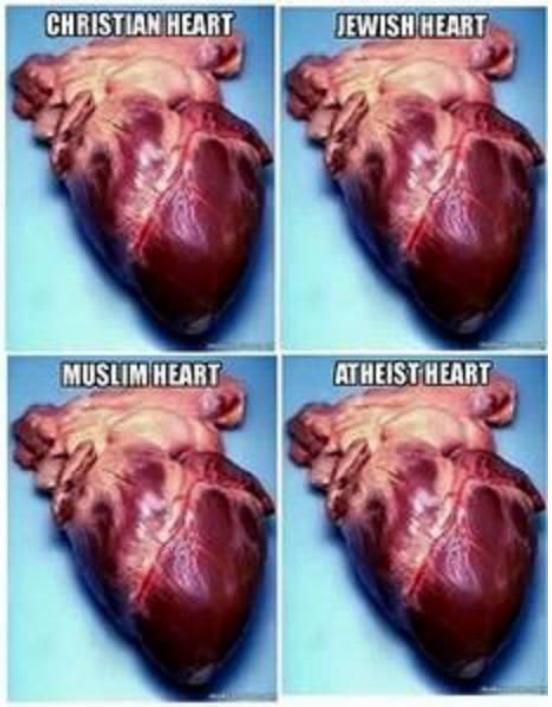
parasympathetic activity
Sympathetic activity
Time lag < 1 s
fast oscillations
Time lag > 6 s
Slow oscillations
CNS (n. vagus)
Heart rate
Spectrum HR (n.u.)
0,2
0,0
0
???
baroreflex
Mechanical transfer
Changes of TPR (sympathetic nerves)
Thoracic pressure changes
Systolic blood pressure
Spectrum SBP (n.u.)
0,12
0,08
0,04
0
0
0.1
0.2
0.3
0.4
0.5
band:
Very low frequency (VLF)
Low frequency (LF)
High frequency (HF)



Not making a point...
Just showing off my collection