



Photoplethysmographic blood pressure measurement

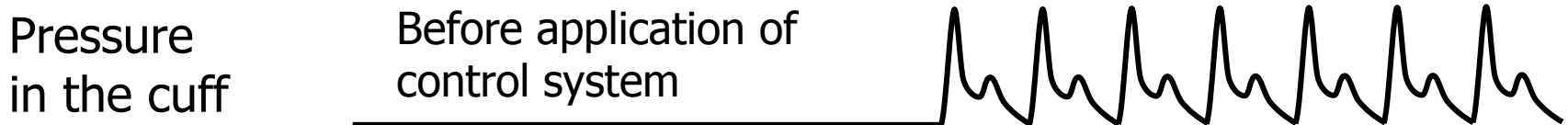
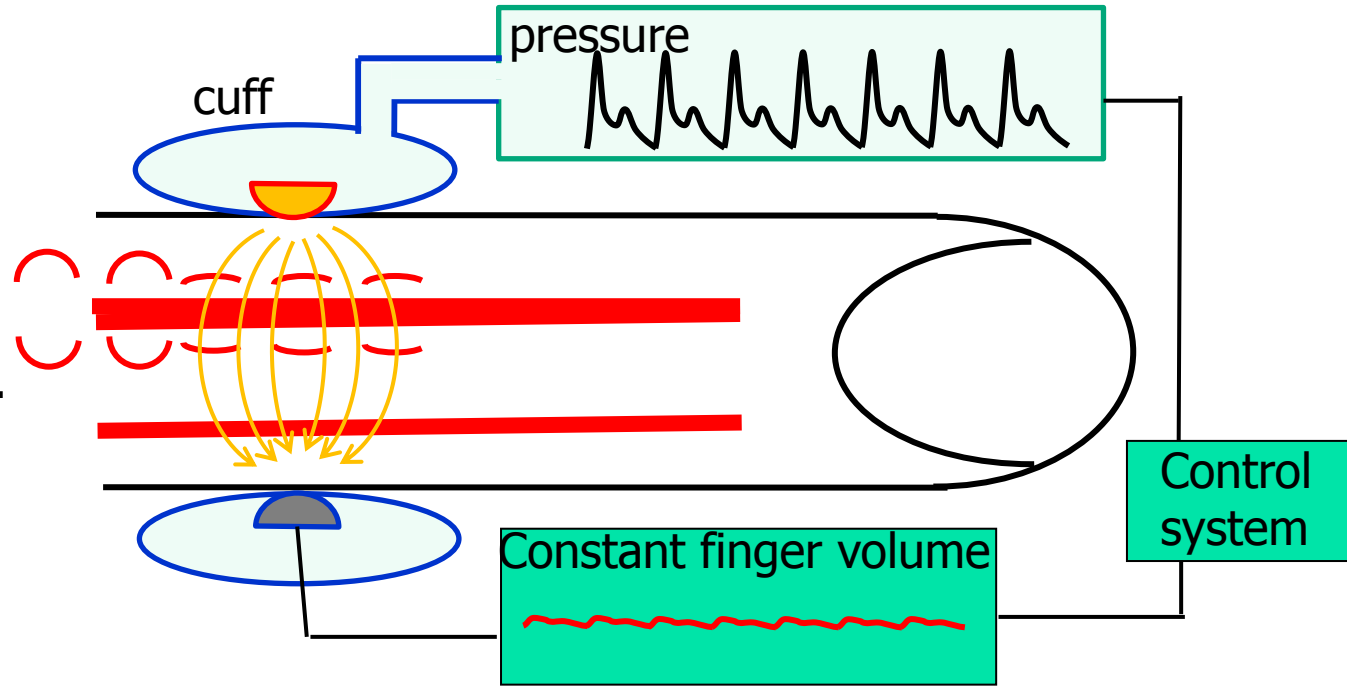
Peňáz's method,
volume-clamp
method



Principle of continual blood pressure measurement

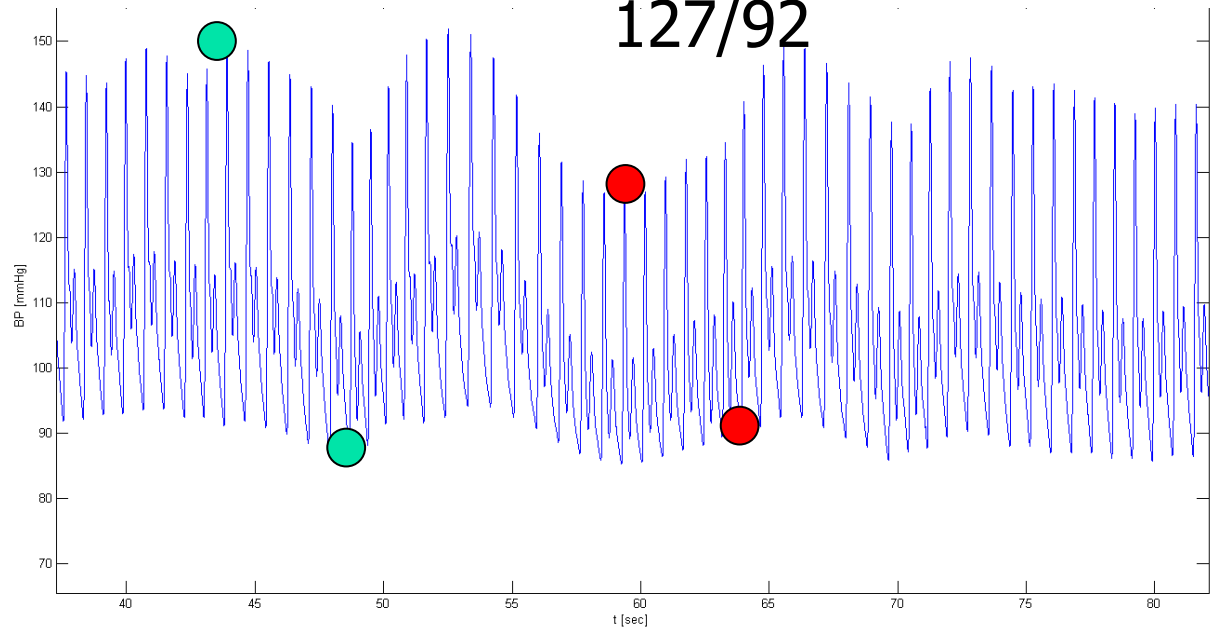
Control system:

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.

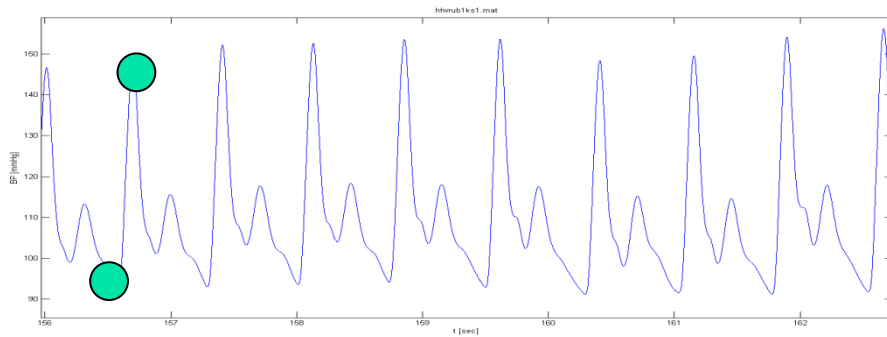


150/90

127/92



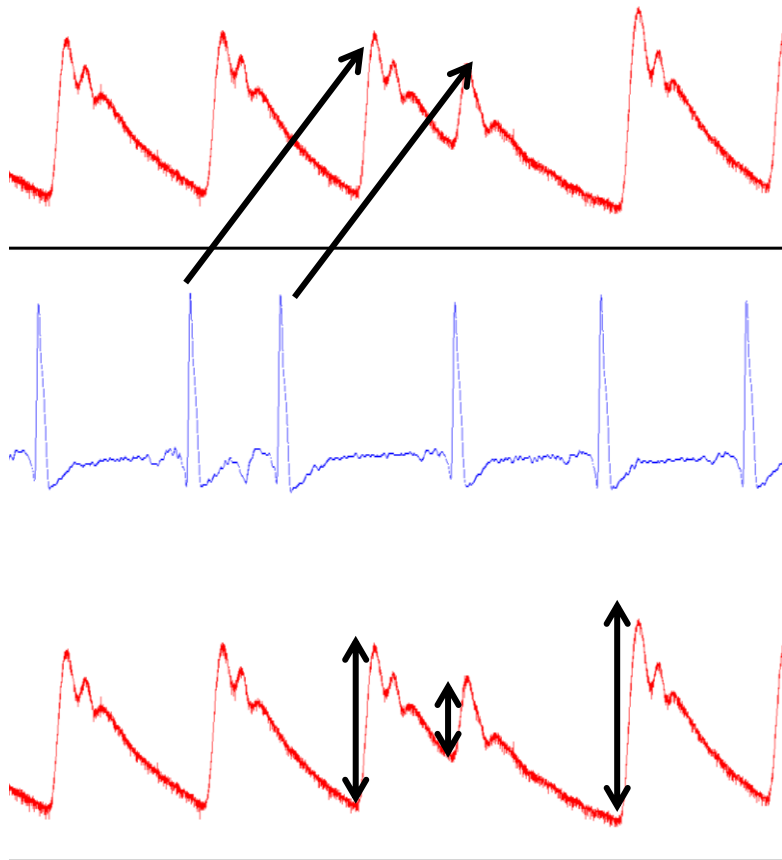
SBP



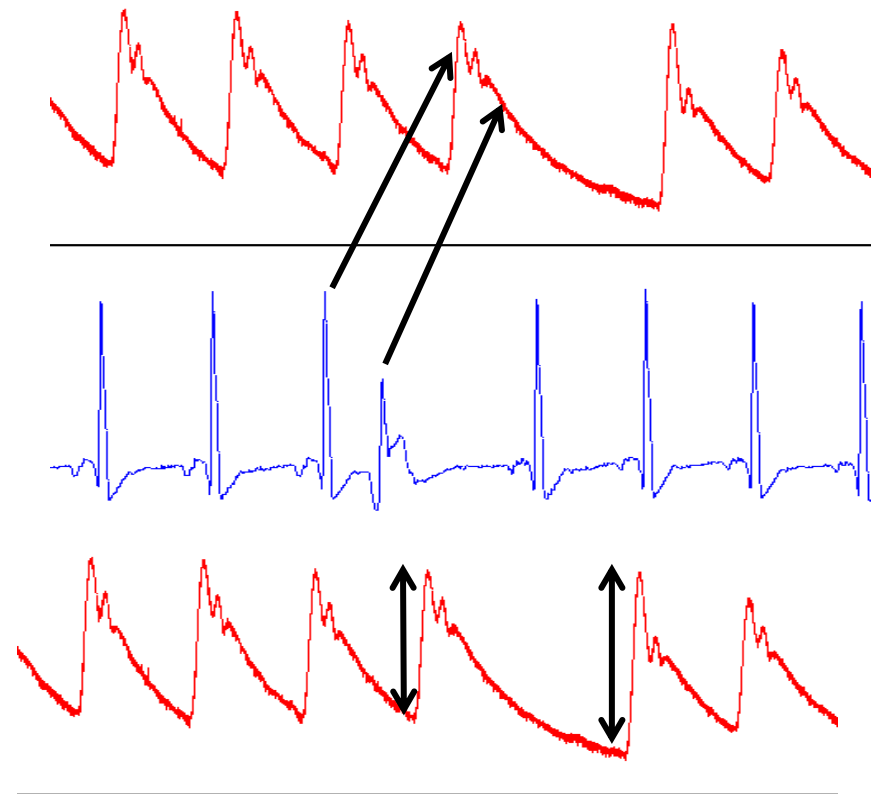
DBP

Extrasystoles

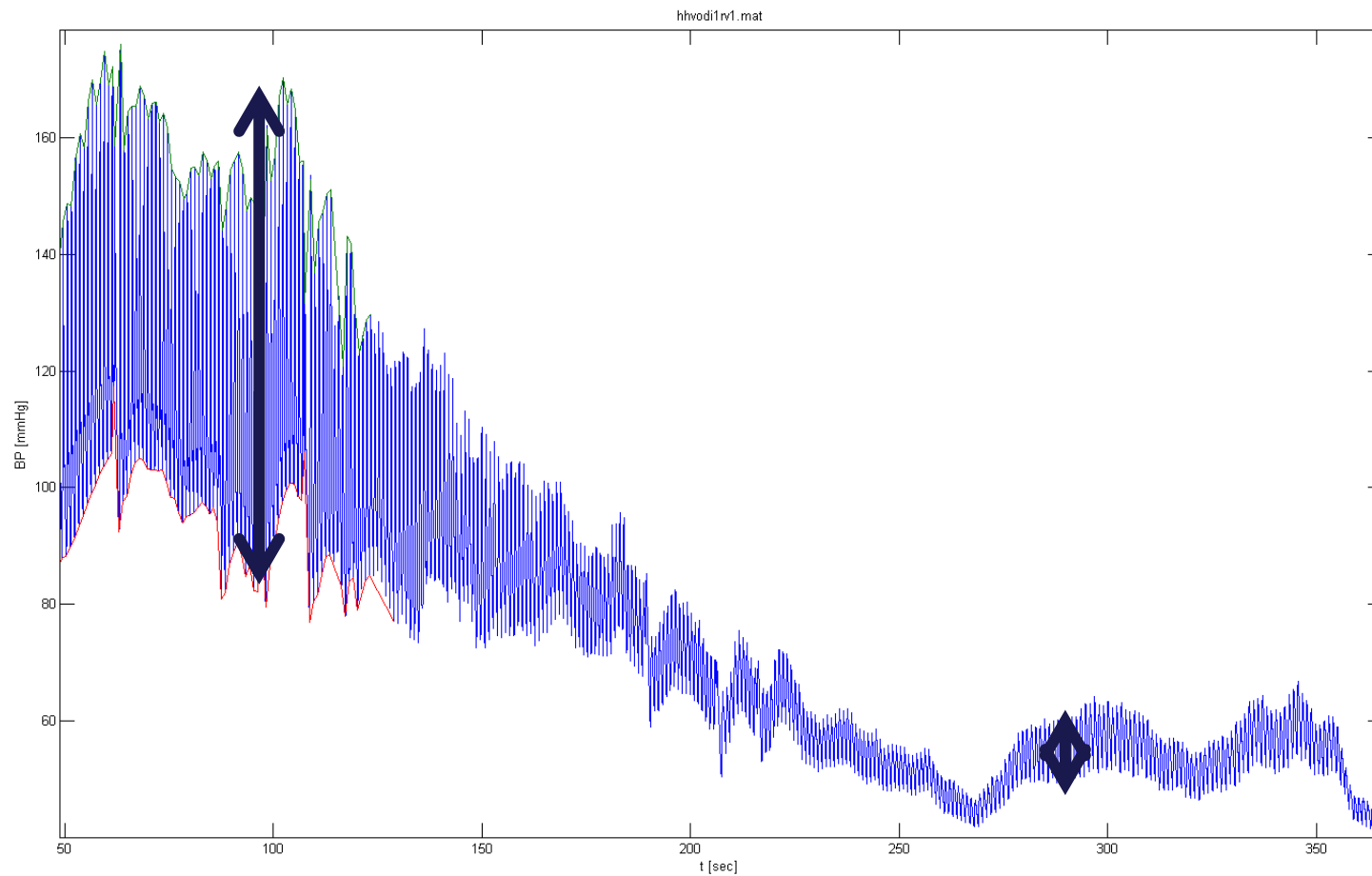
supraventricular



ventricular

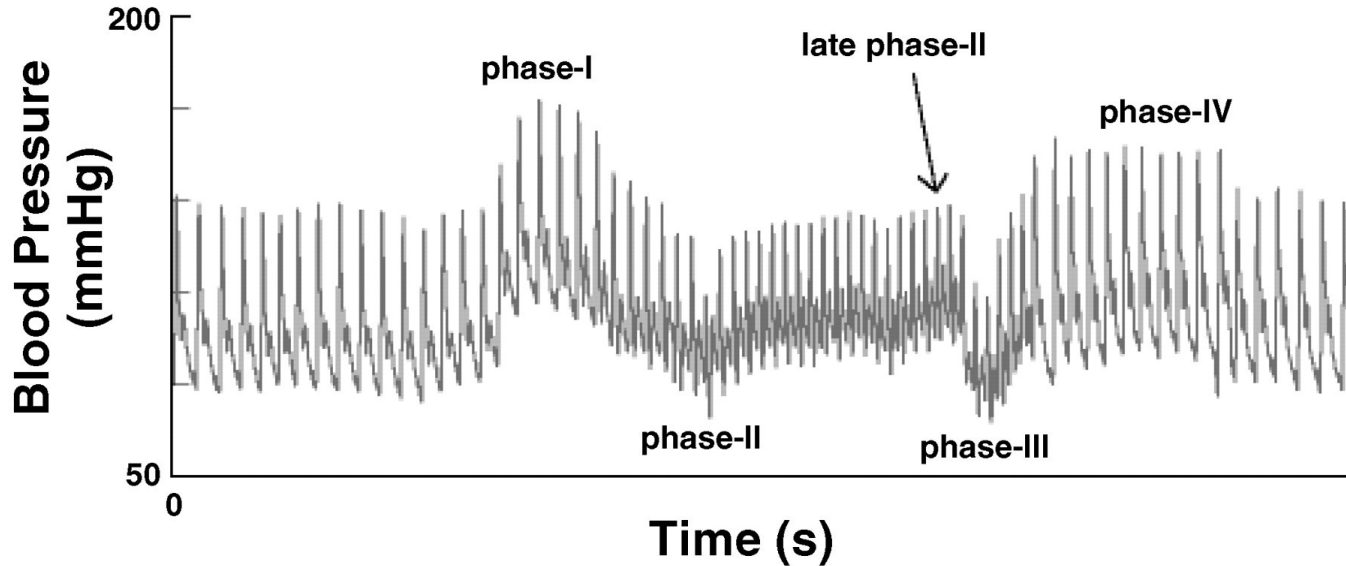


Orthostatic hypotension

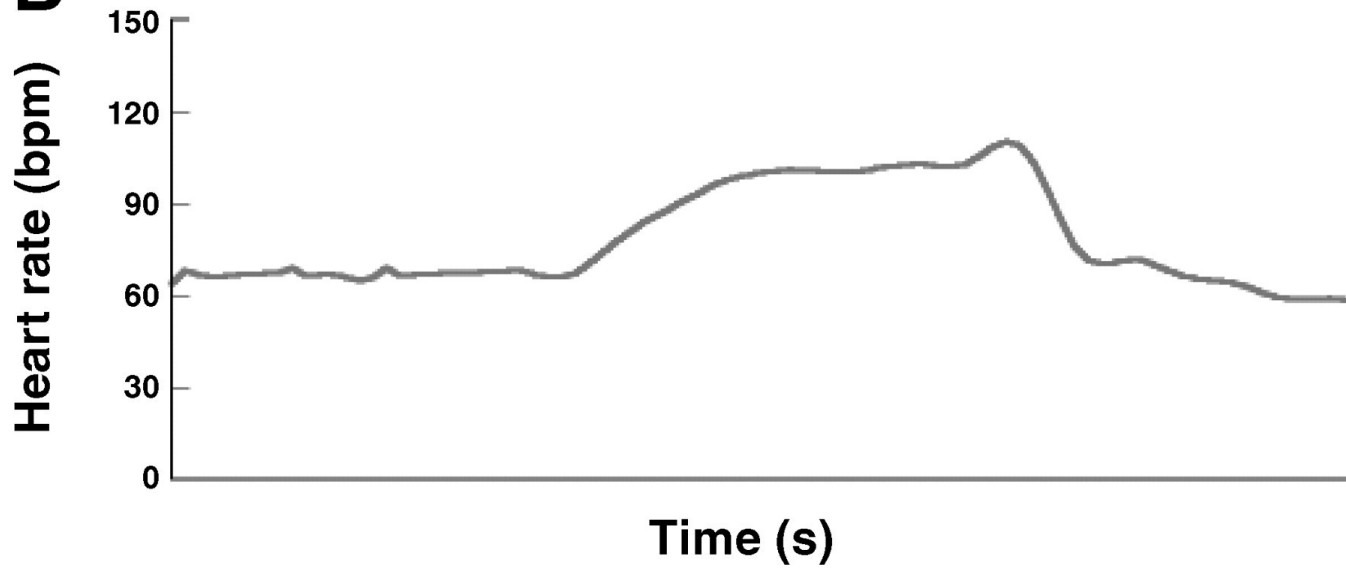


Valsalva manoeuvre

A



B





See videos:

oscilometric method of BP measurement

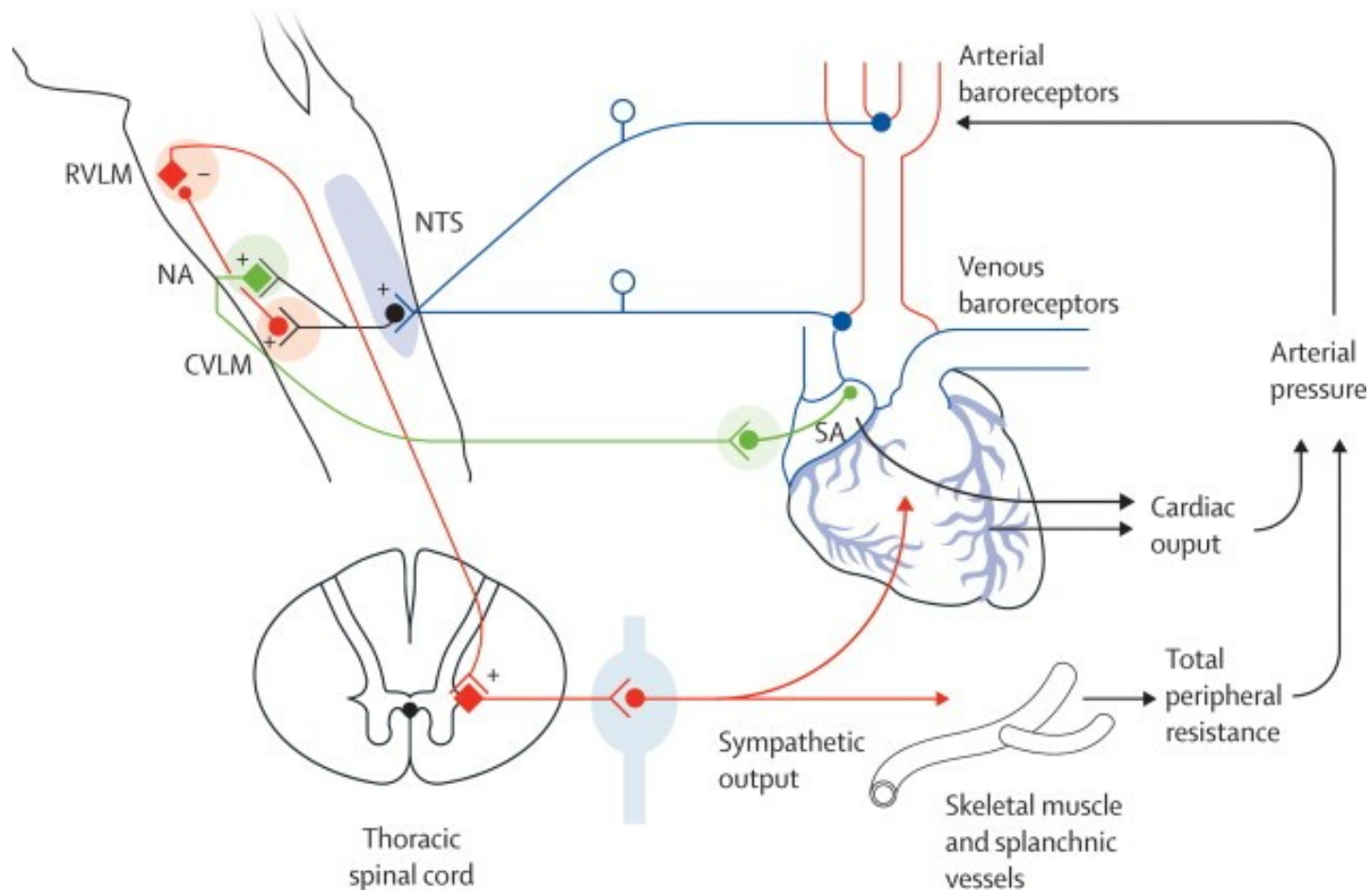
<https://www.youtube.com/watch?v=Y-NvovSaWTc&t=113s>

BP changes during smoking

<https://www.youtube.com/watch?v=J5vPJPfNH3k&t=1s>

Baroreflex

Fast regulation of arterial blood pressure by changes of heart rate and peripheral vascular resistance



Baroreflex

peripheral (vascular, sympathetic) branch of baroreflexu

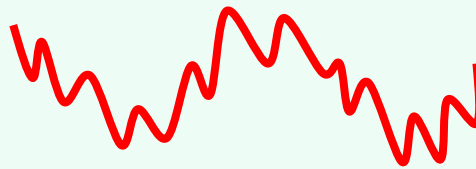
resistance arteries

signal: peripheral resistance



arteries

signal: blood pressure



heart

signal: heart rate

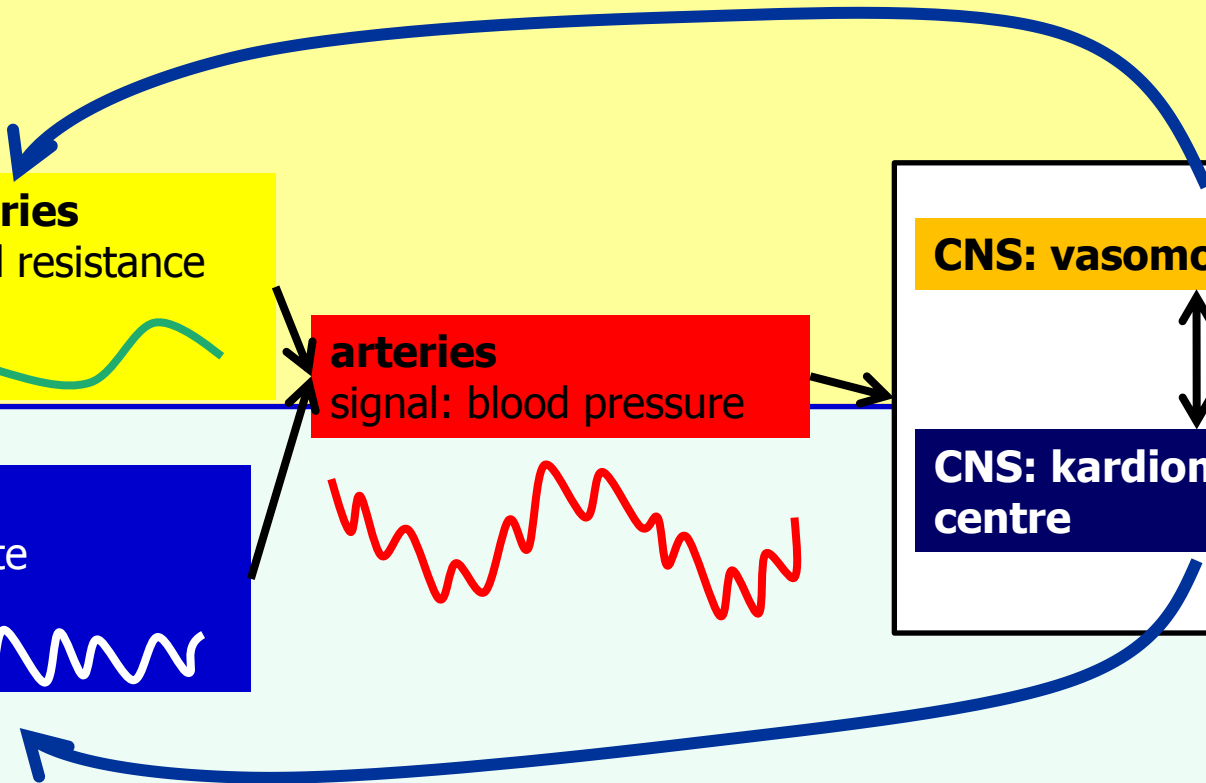


CNS: vasomotor centre



CNS: kardiomotor centre

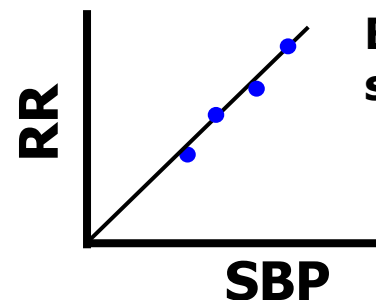
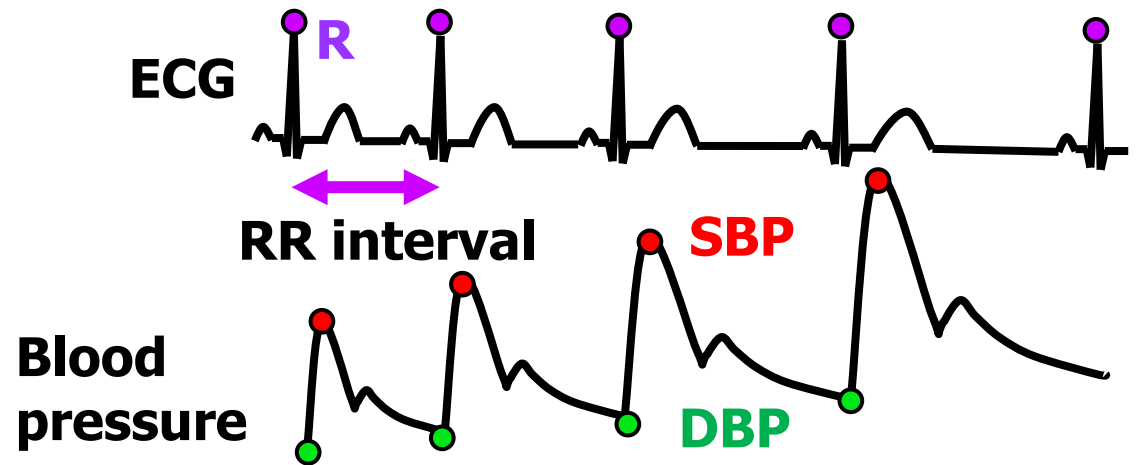
Cardiac (parasympathetic) branch



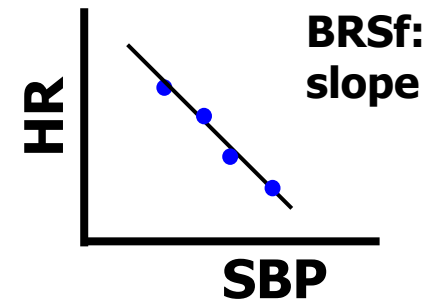
Baroreflex sensitivity, BRS

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]



BRS:
slope



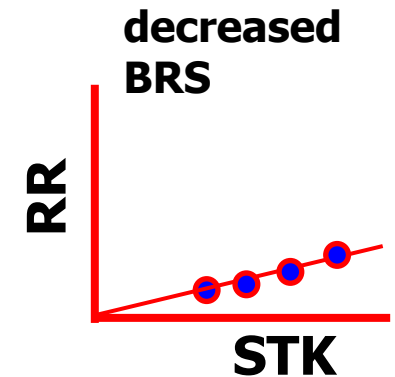
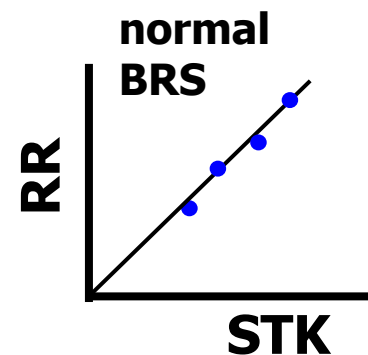
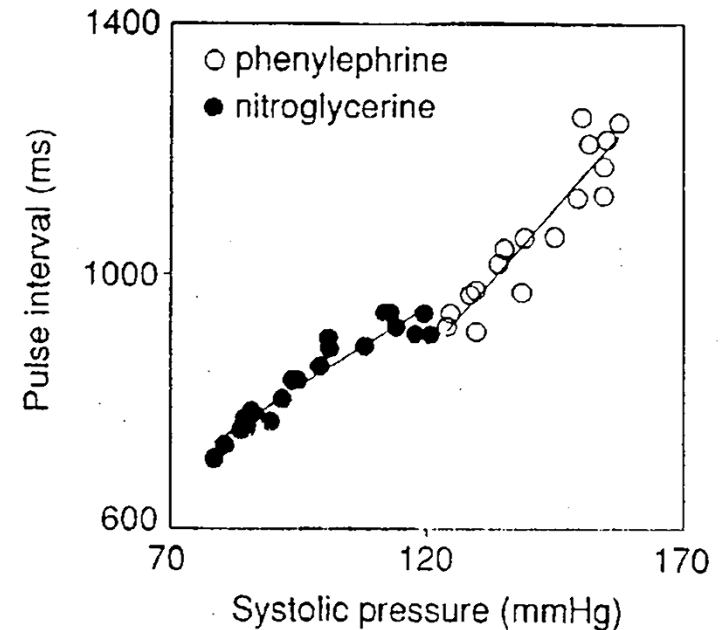
BRSf:
slope

Evaluation of BRS

Standard(oxford) method:

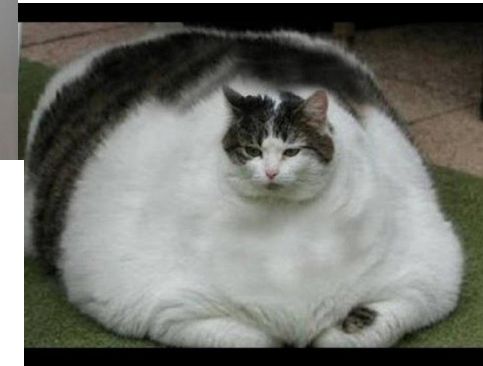
- Application of phenylephrine (vasoconstrictor)

Bolus injections of vasoactive drugs



Decreased BRS

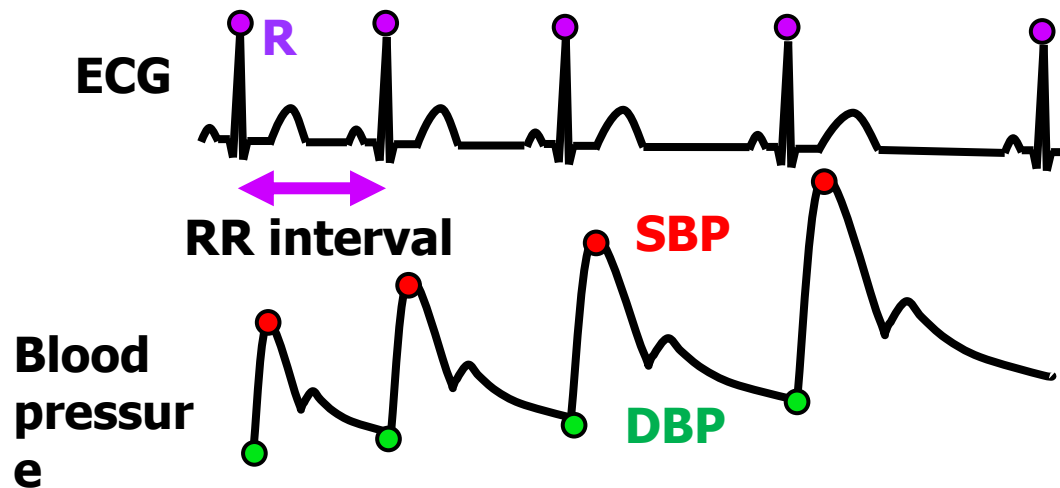
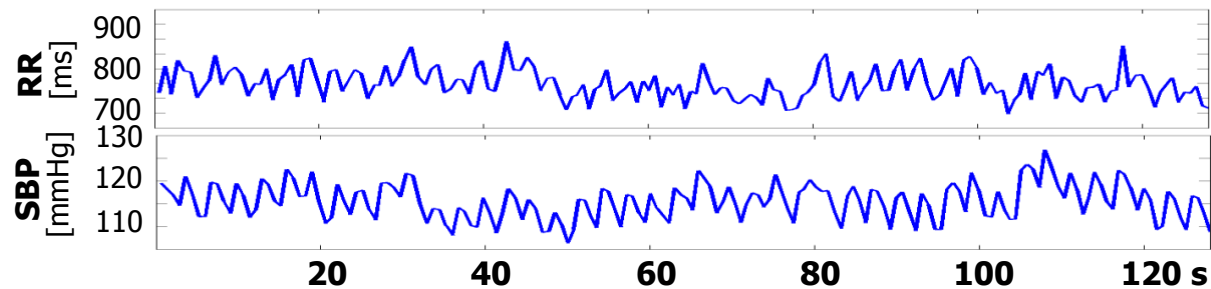
- Physiologically
 - psychic stress – increased sympathetic activity
 - Physical exercise – increased sympathetic activity
 - In old age
- Pathologically
 - hypertension – decreased baroreceptor sensitivity (atherosclerosis, increased arterial stiffness)
 - diabetes – neuropathy of autonomic nervous system
 - Chronic depression (neurogenic)
 - Heart insufficiency/failure – heart do not response
 - Transplanted heart - denervation
 - Myocardial infarction – heart do not response



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



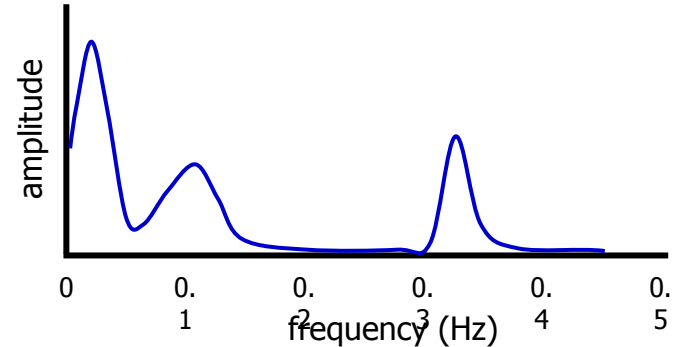
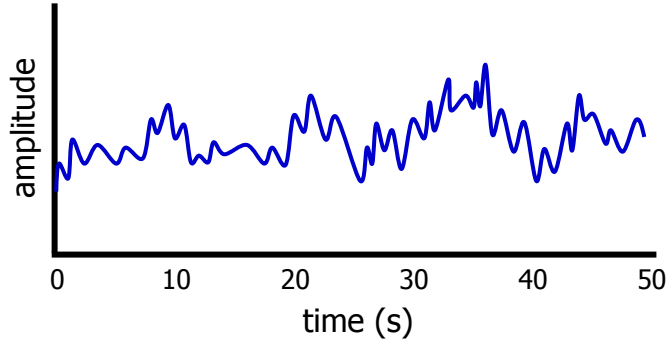
Frequency domain methods – spectral analysis

Time series
Signal in time domain



Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies



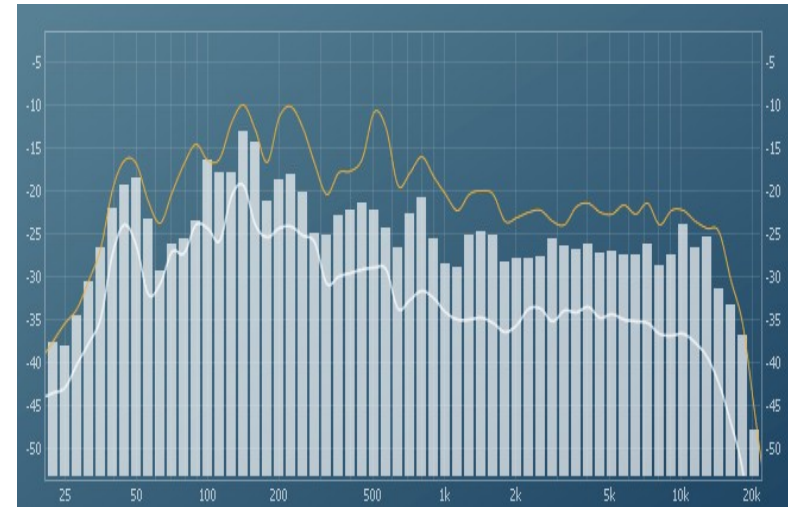
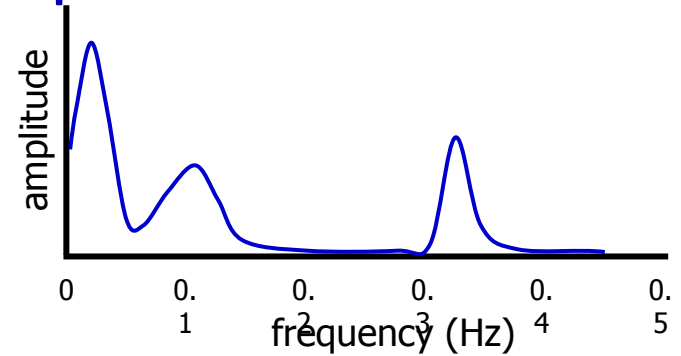
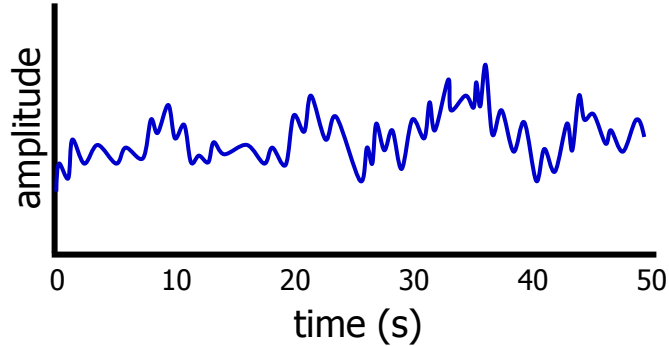
Frequency domain methods – spectral analysis

Time series
Signal in time domain



Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies



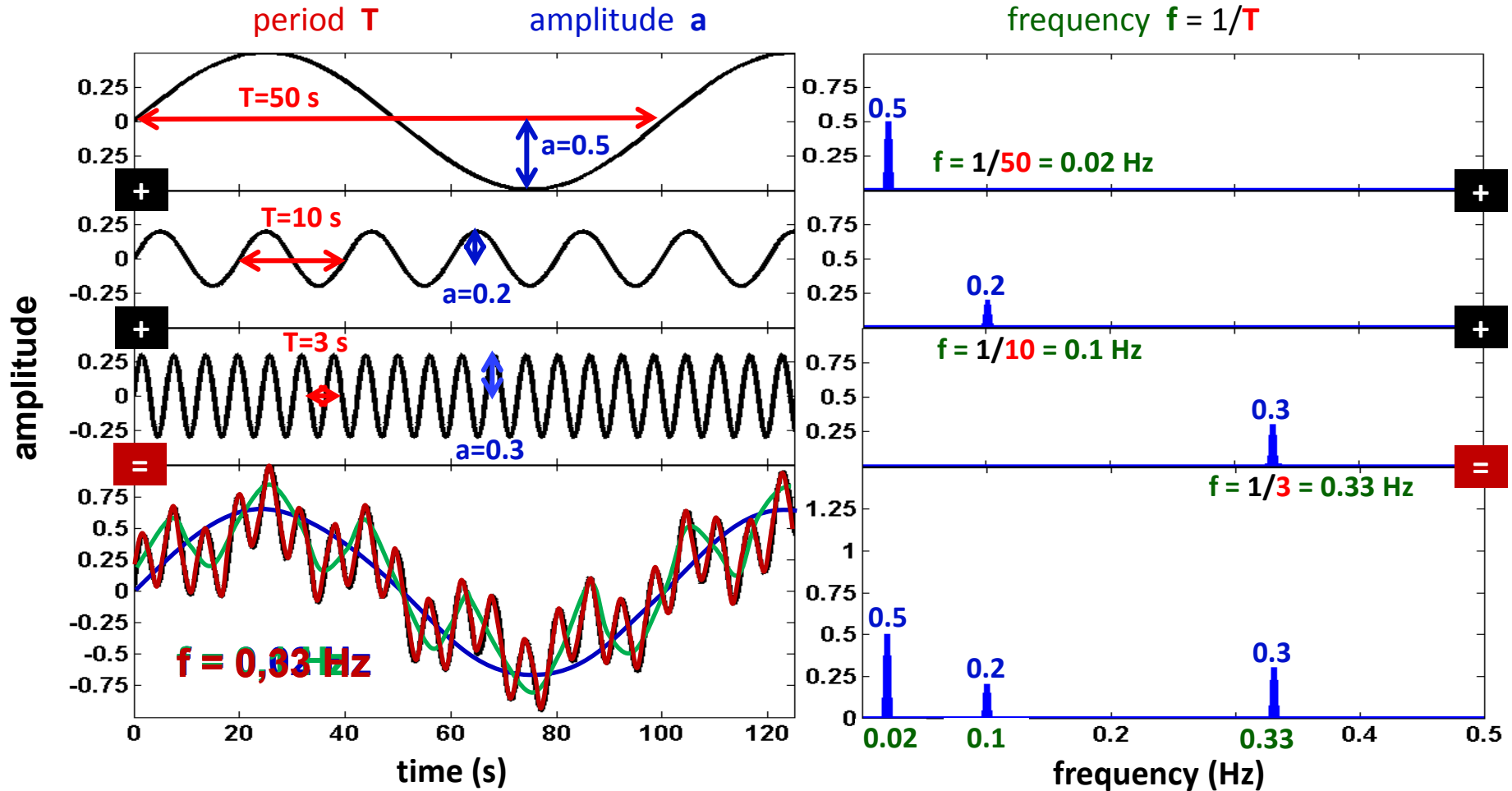


How the spectrum is formed?

Spectrum

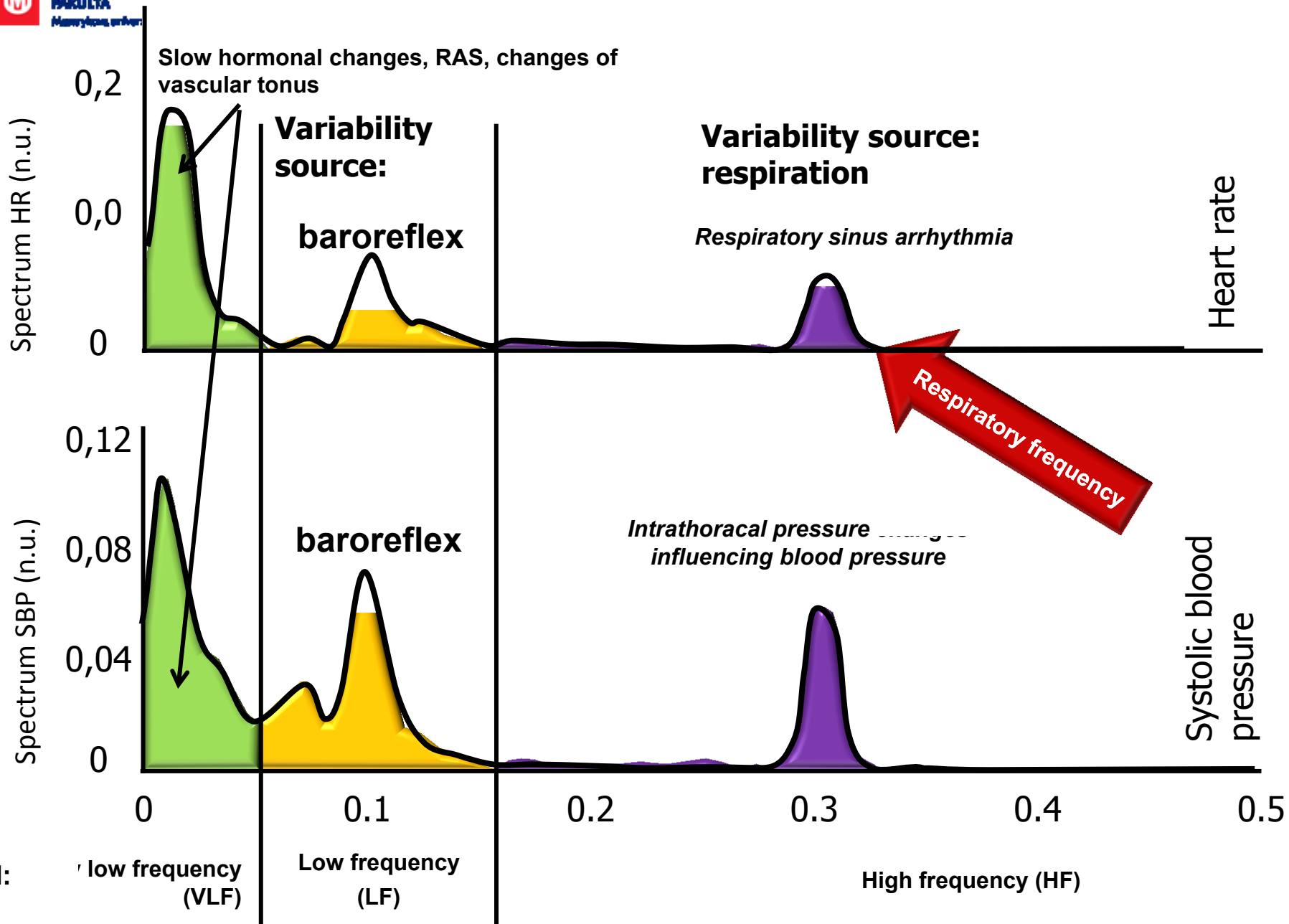
Frequency domain

Time domain





Physiological significance – frequency bands

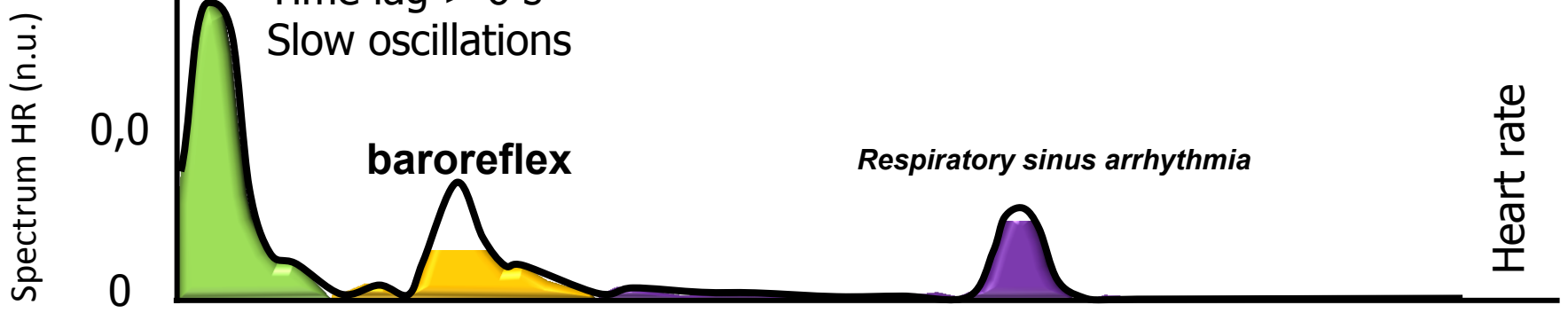


← **parasympathetic activity**

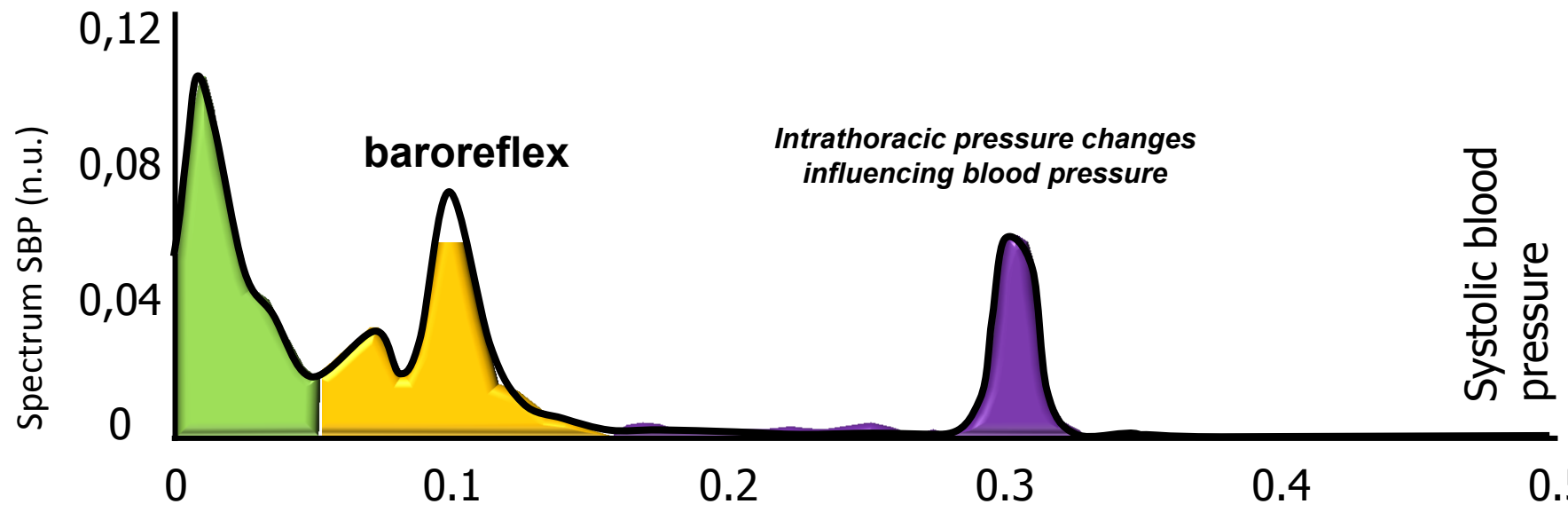
← **Sympathetic activity**

Time lag < 1 s
Fast oscillations

Time lag > 6 s
Slow oscillations



Heart rate



Systolic blood pressure

band: low frequency (VLF) Low frequency (LF) High frequency (HF)



parasympathetic activity

Sympathetic activity

Time lag < 1 s
fast oscillations

Time lag > 6 s
Slow oscillations

Spectrum HR (n.u.)

0,2
0,0
0

Heart rate

CNS (*n. vagus*)

baroreflex

Mechanical transfer

??

Changes of TPR
(sympathetic nerves)

Thoracic pressure changes

Spectrum SBP (n.u.)

0,12
0,08
0,04
0

Systolic blood pressure

0

0.1

0.2

0.3

0.4

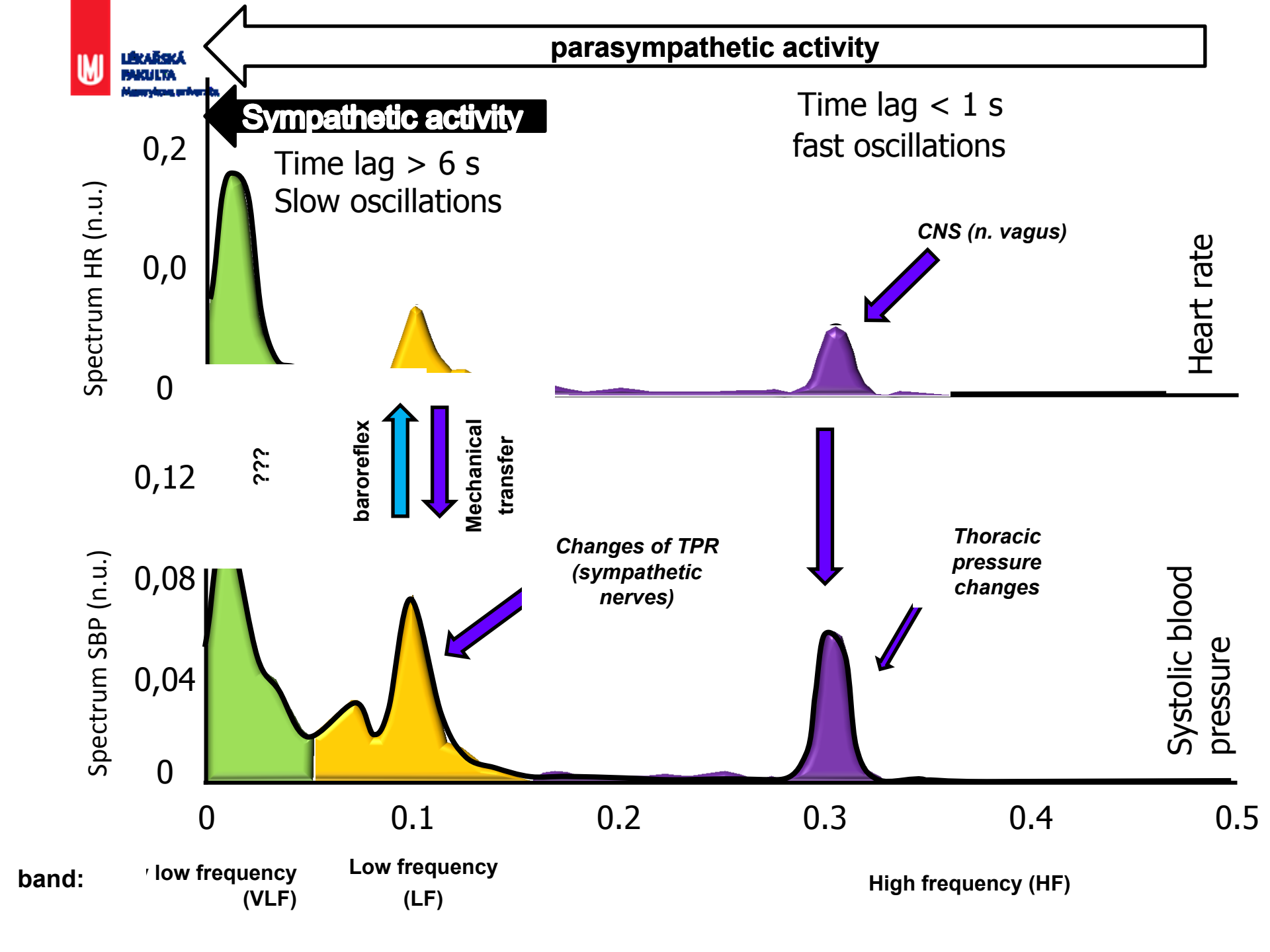
0.5

band:

low frequency (VLF)

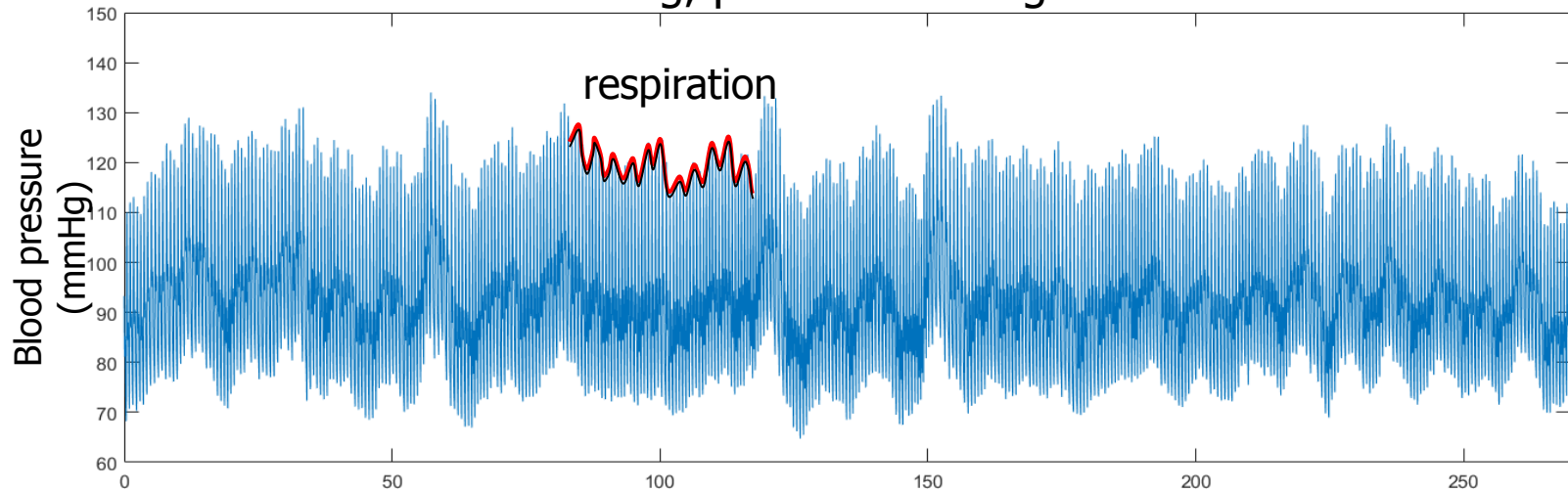
Low frequency (LF)

High frequency (HF)

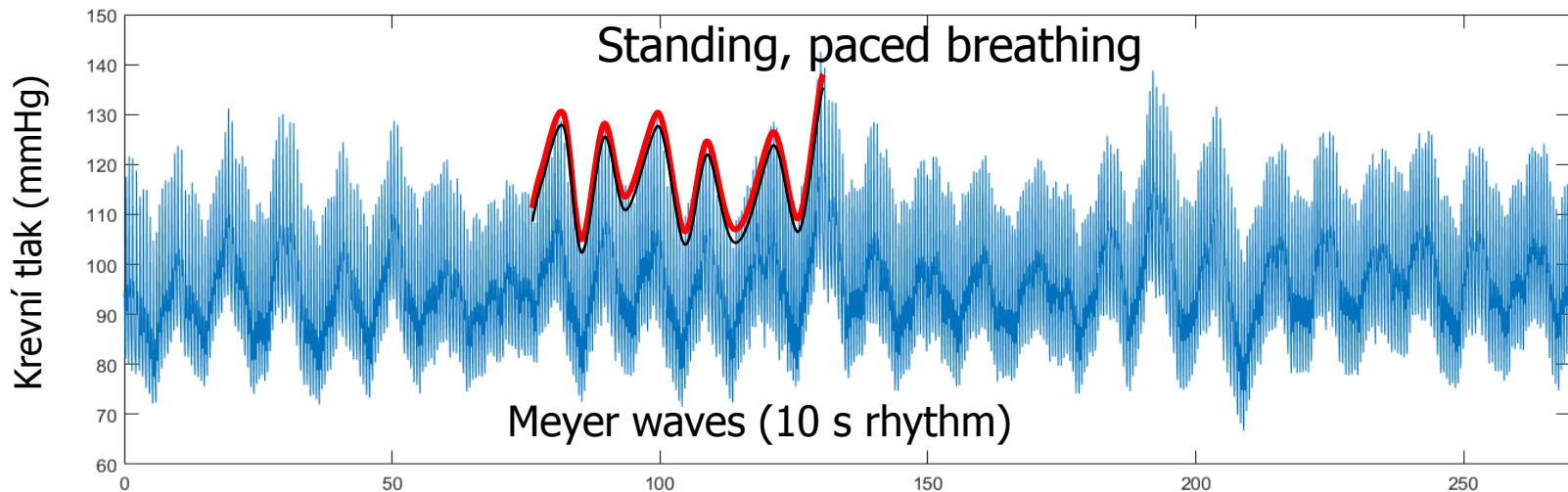


Blood pressure signal (270 s)

Sitting, paced breathing



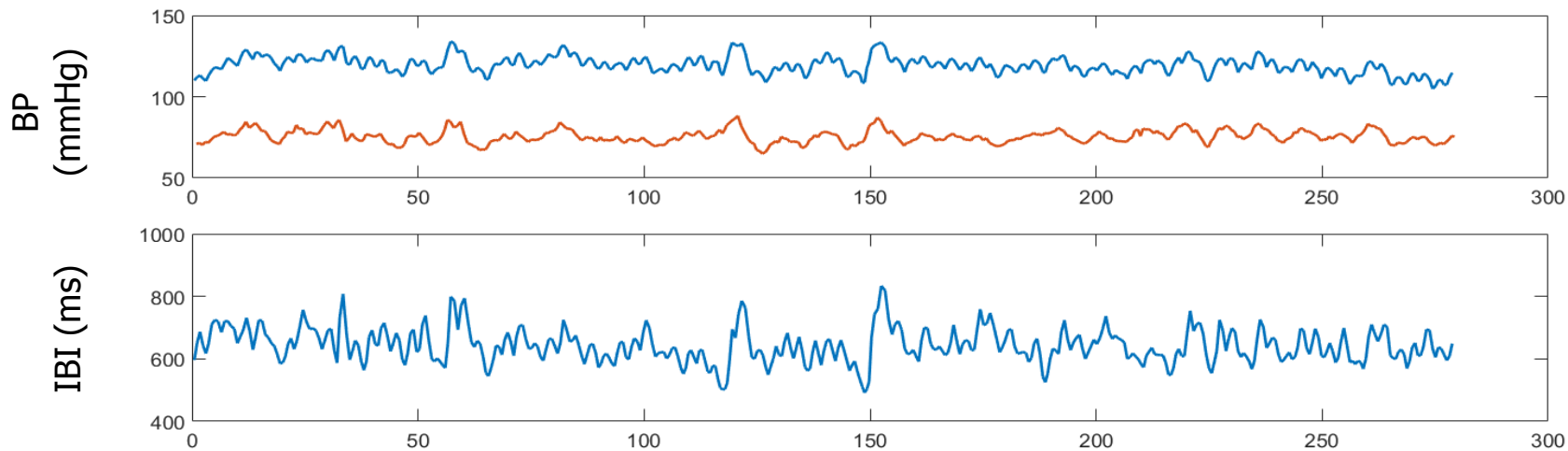
Standing, paced breathing



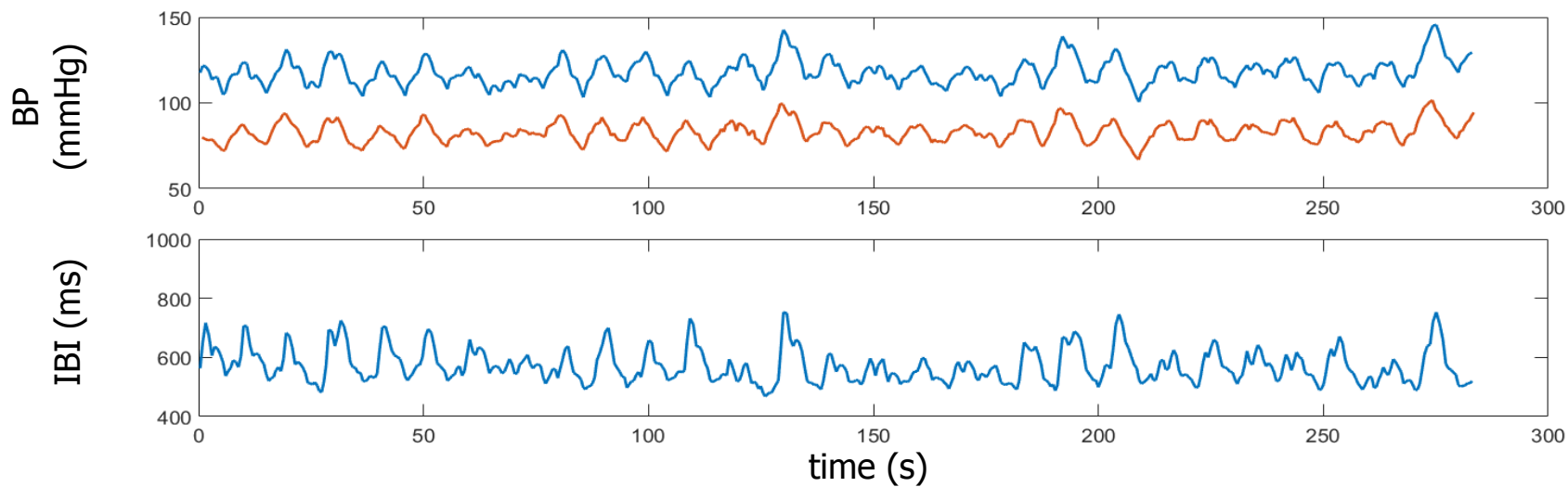
time (s)

sequences of SBP, DBP and inter-beat intervals

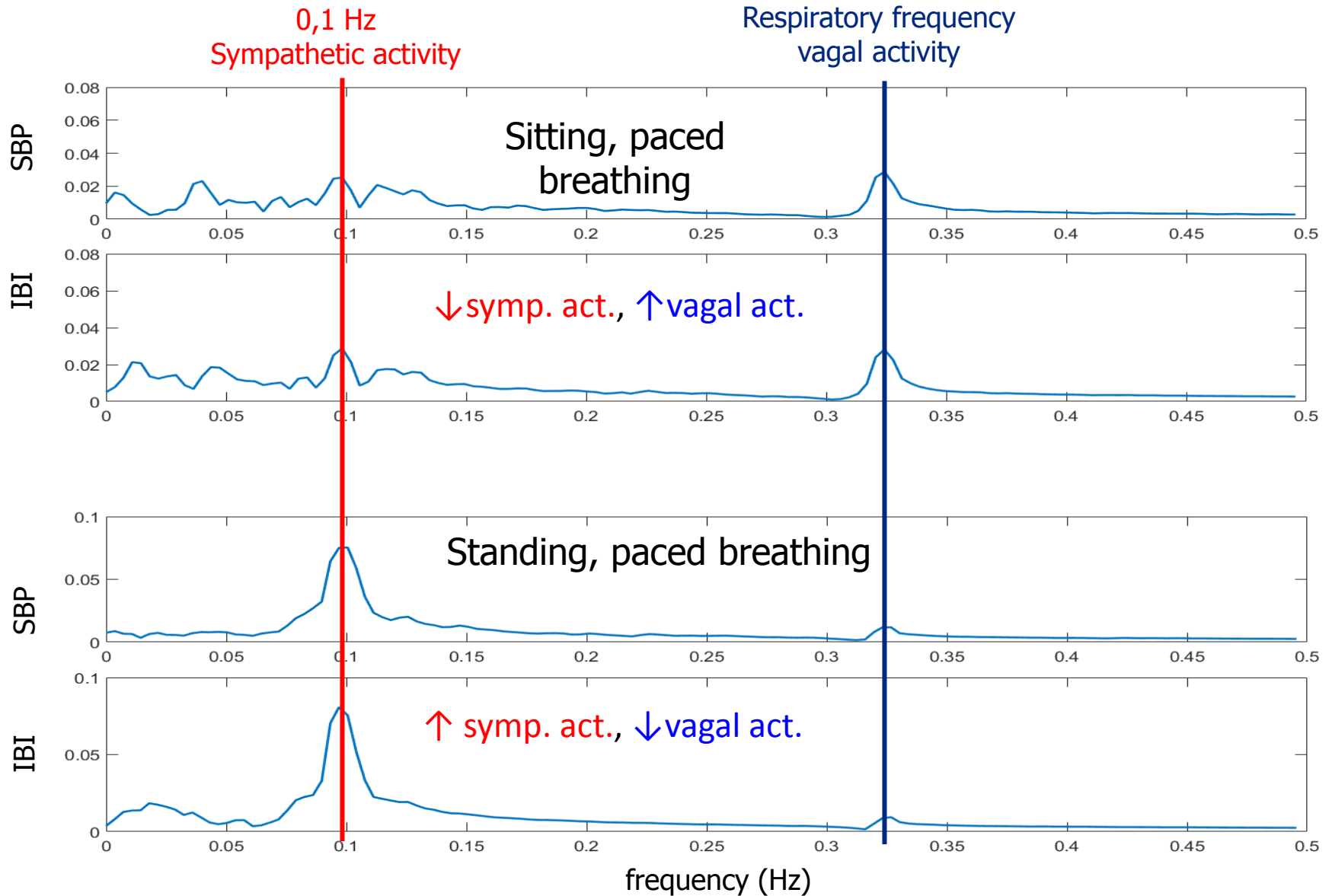
Sitting, paced breathing



Standing, paced breathing



Spectra of SBP and IBI



Coherence a BRS

coherence: synchronization between signals (correlation on particular frequency)

