



Photoplethysmographic blood pressure measurement

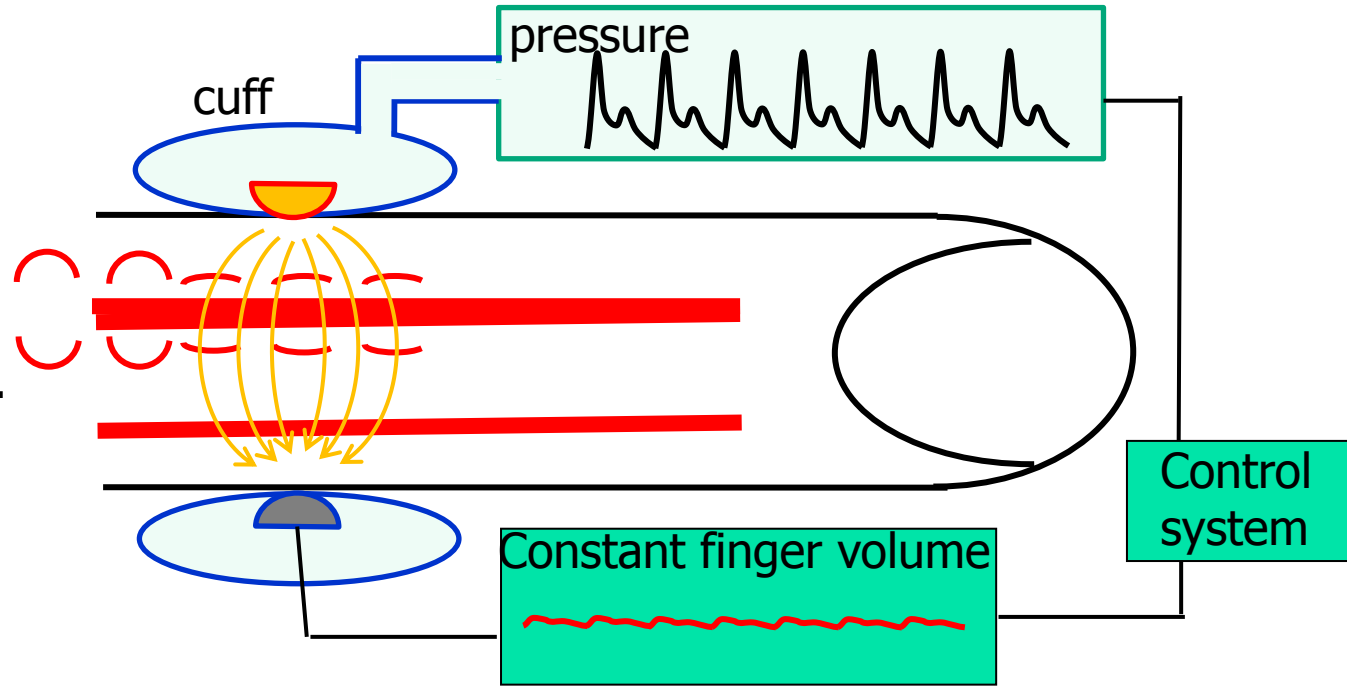
Peňáz's method,
volume-clamp
method



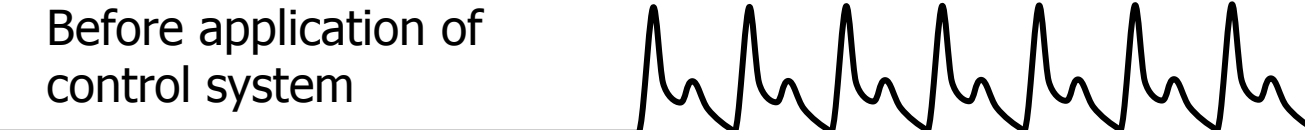
Principle of continual blood pressure measurement

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.

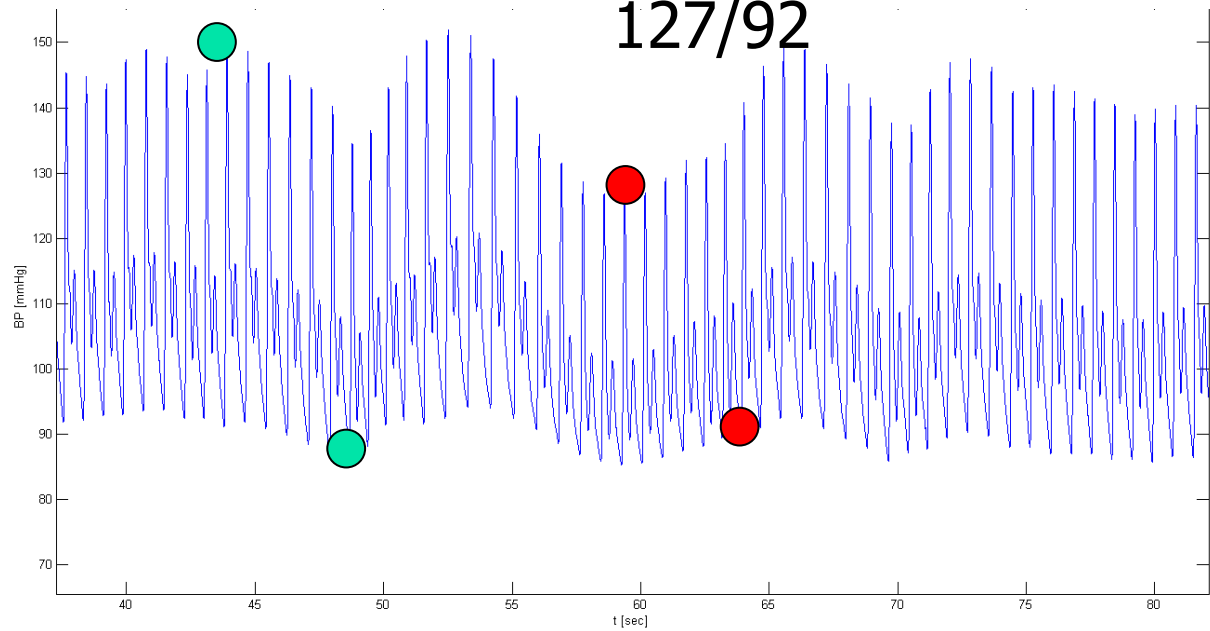


Arterial lumen (finger volume)  application of control system

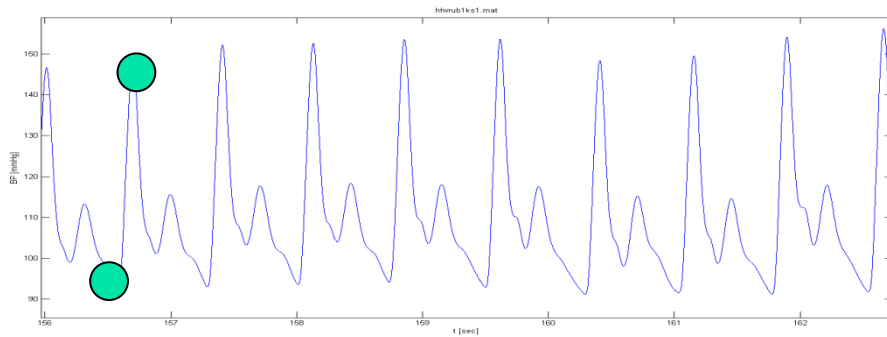
Pressure in the cuff  Before application of control system

150/90

127/92



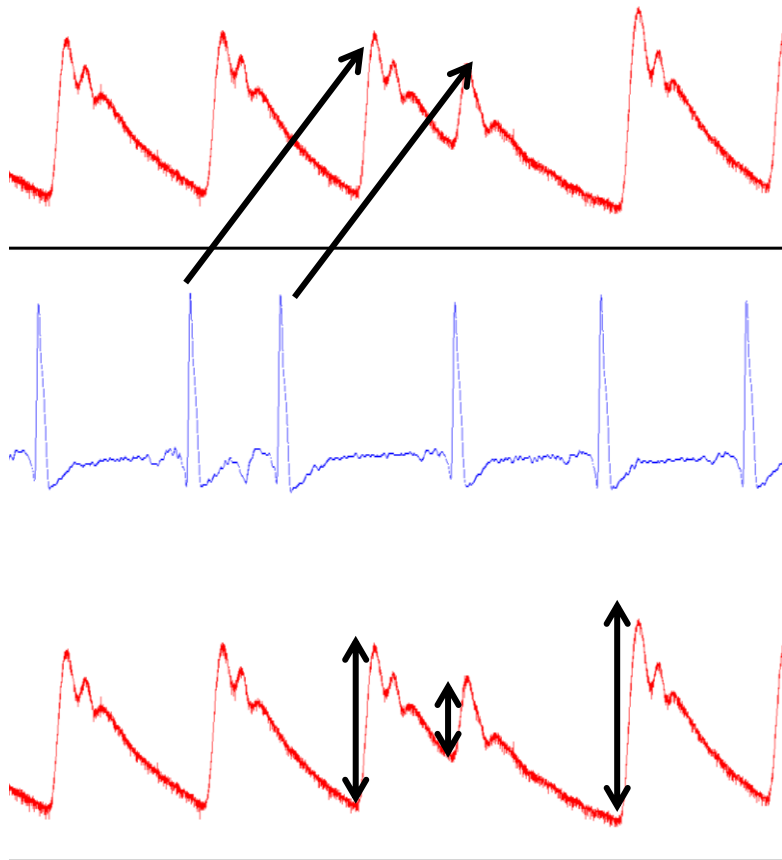
SBP



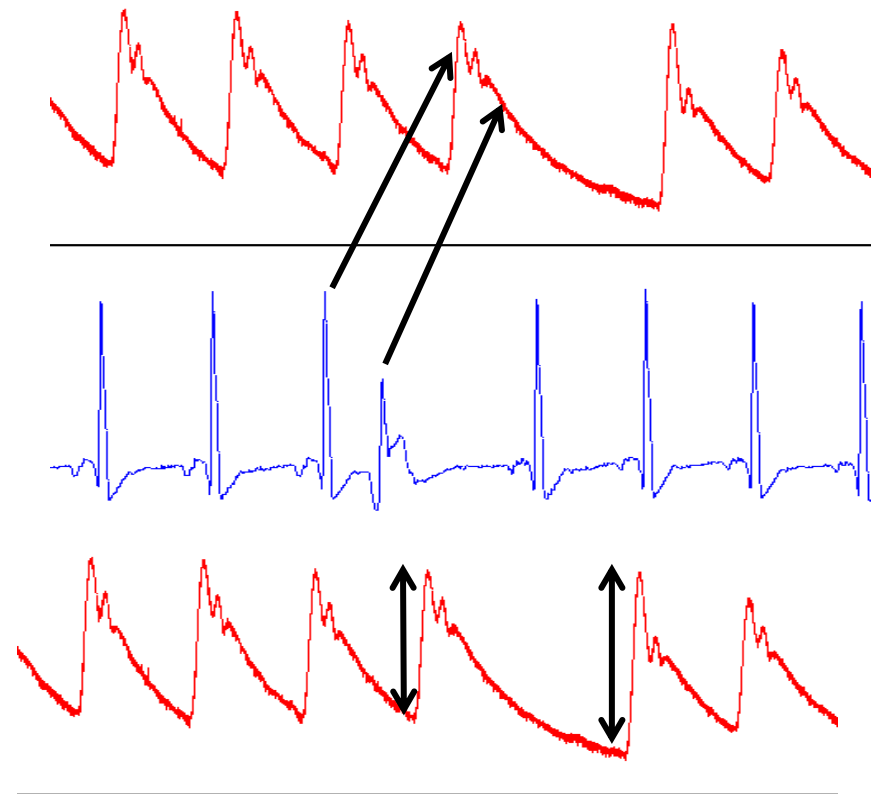
DBP

Extrasystoles

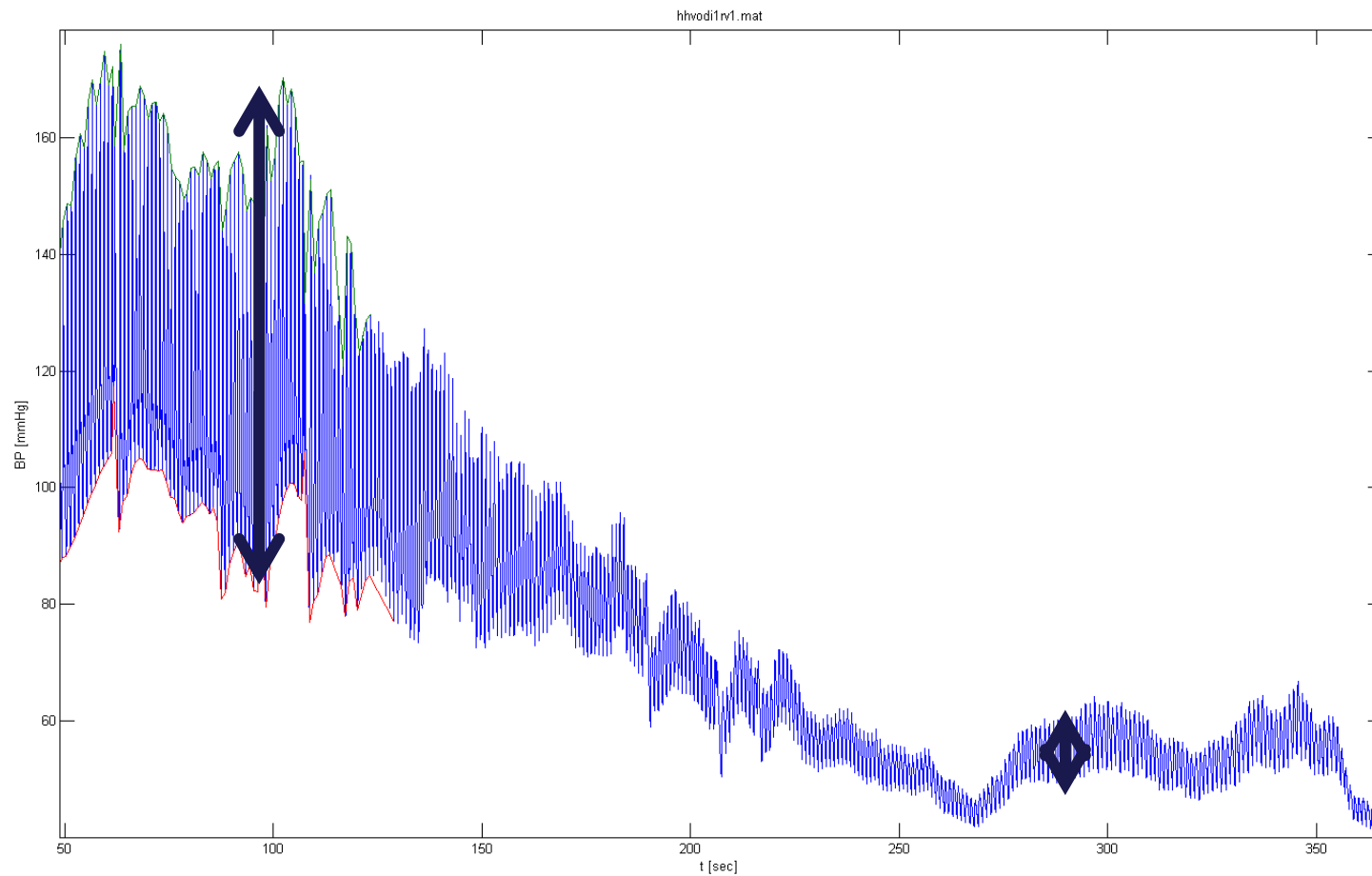
supraventricular



ventricular

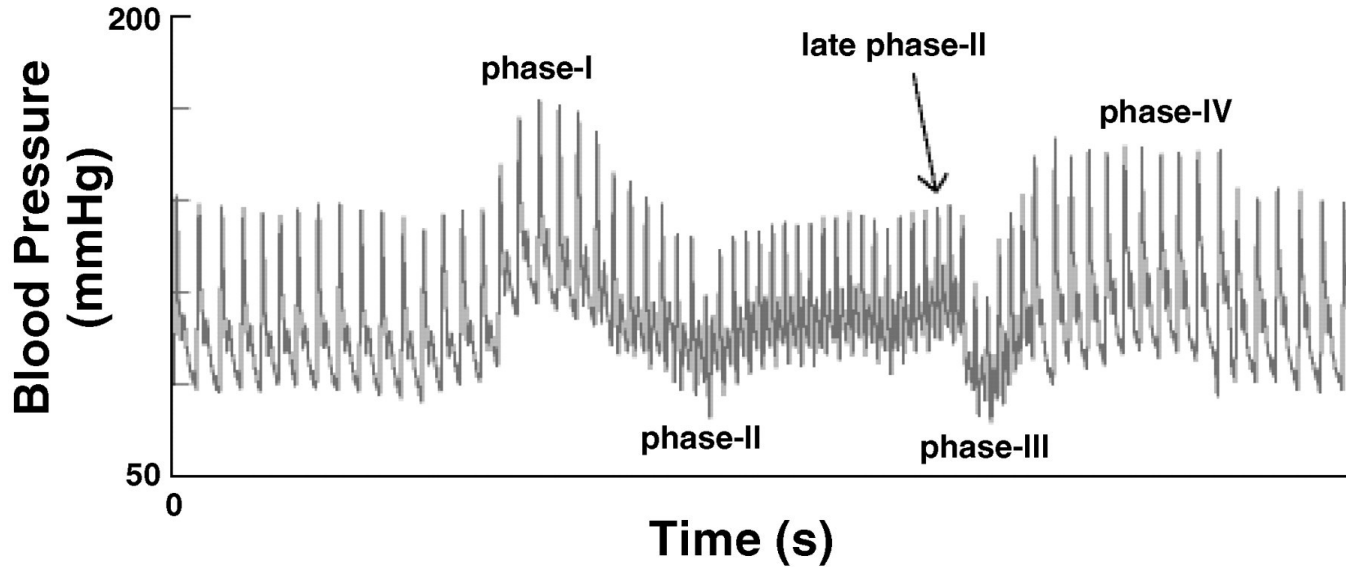


Orthostatic hypotension

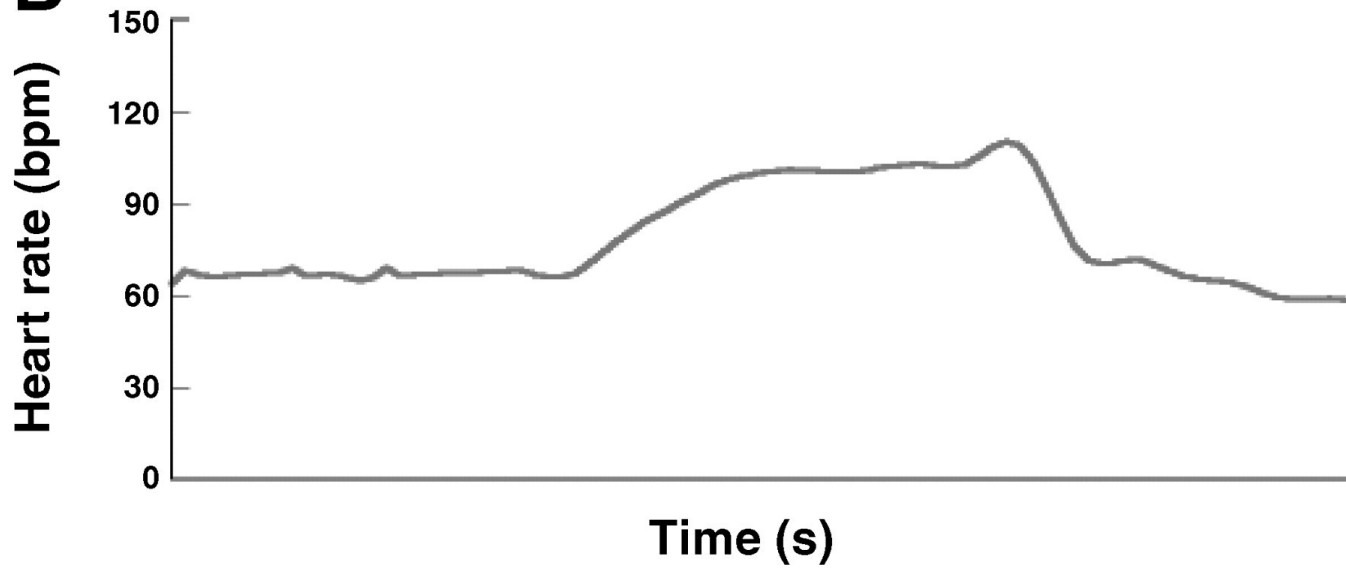


Valsalva manoeuvre

A



B





See videos:

oscilometric method of BP measurement

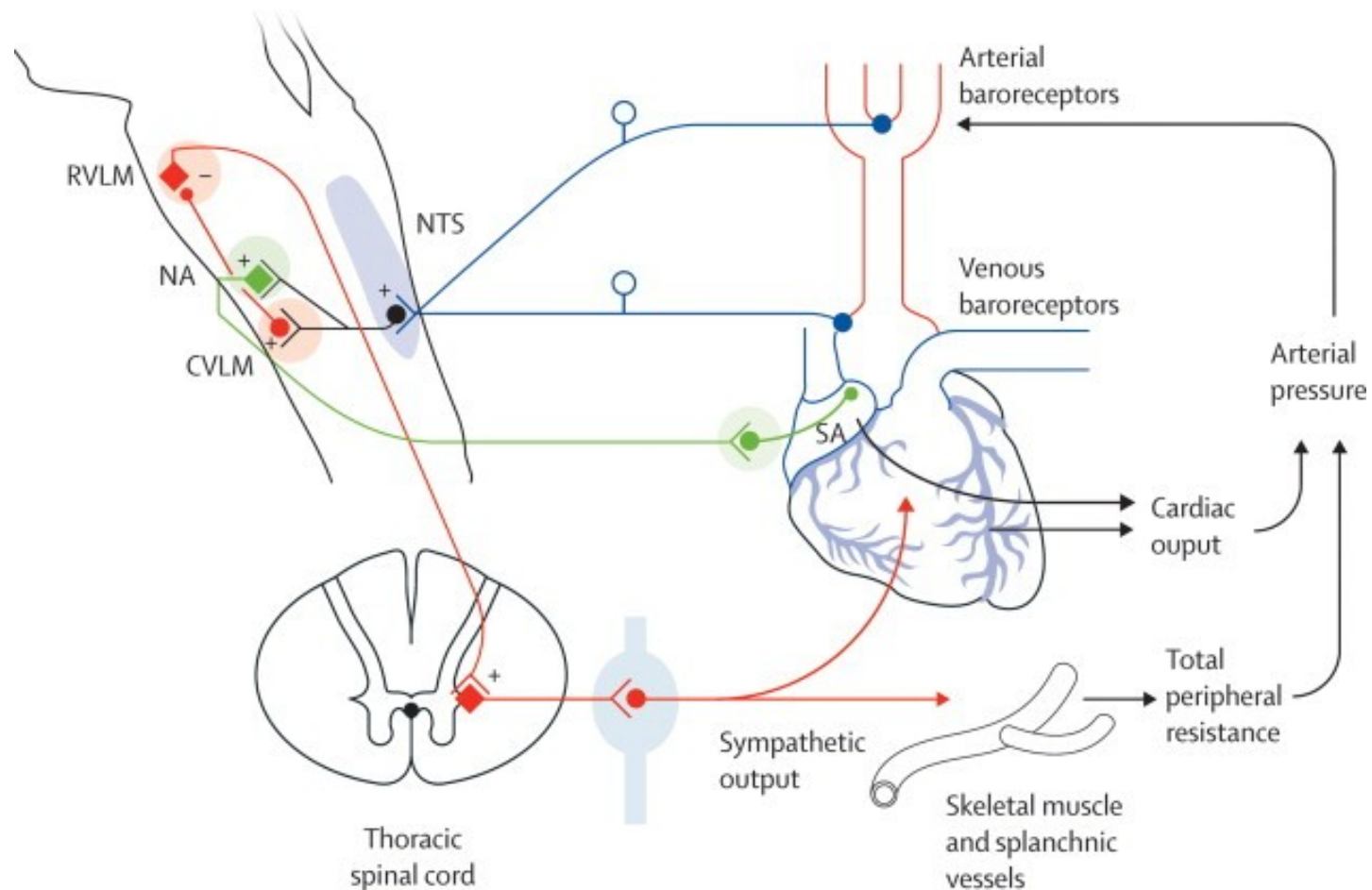
<https://www.youtube.com/watch?v=Y-NvovSaWTc&t=113s>

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



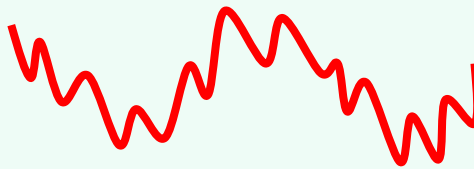
Baroreflex

peripheral (vascular, sympathetic) branch of baroreflexu

resistance arteries
signal: peripheral resistance



arteries
signal: blood pressure



heart
signal: heart rate

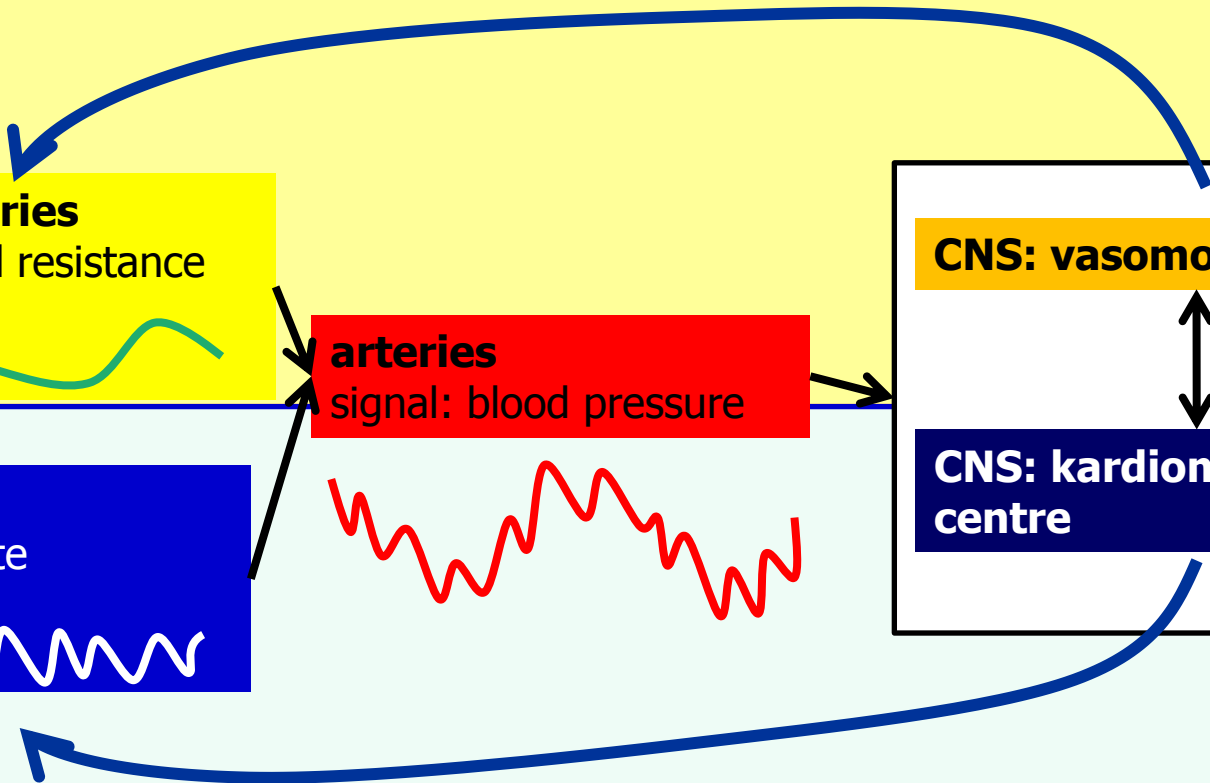


CNS: vasomotor centre



CNS: kardiomotor centre

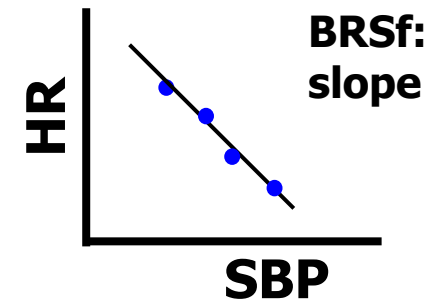
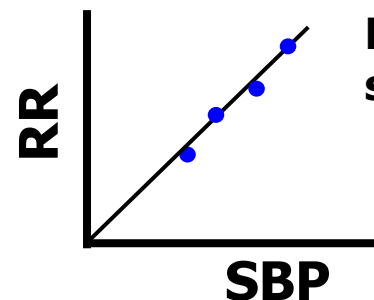
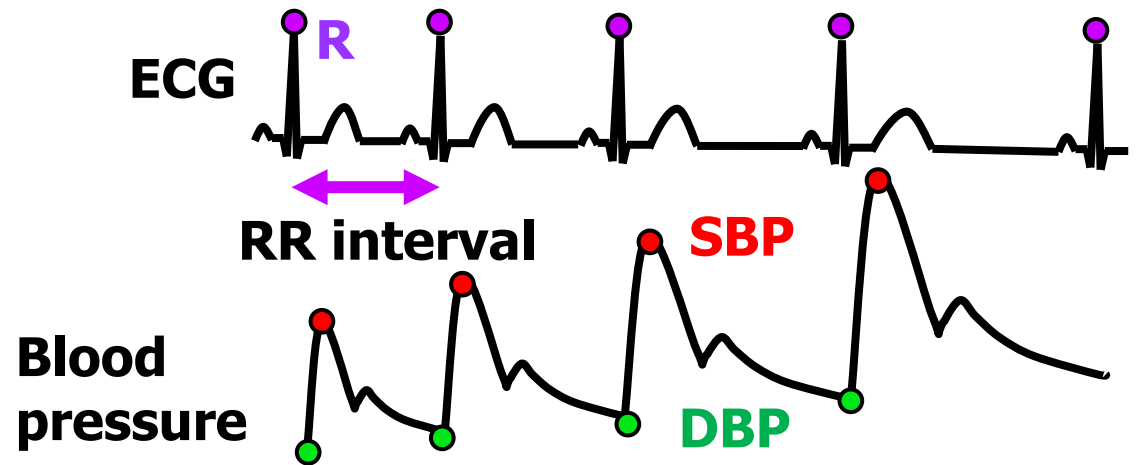
Cardiac (parasympathetic) branch



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]

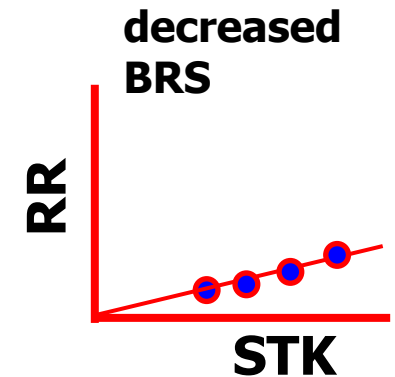
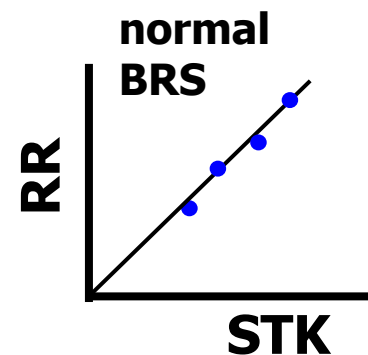
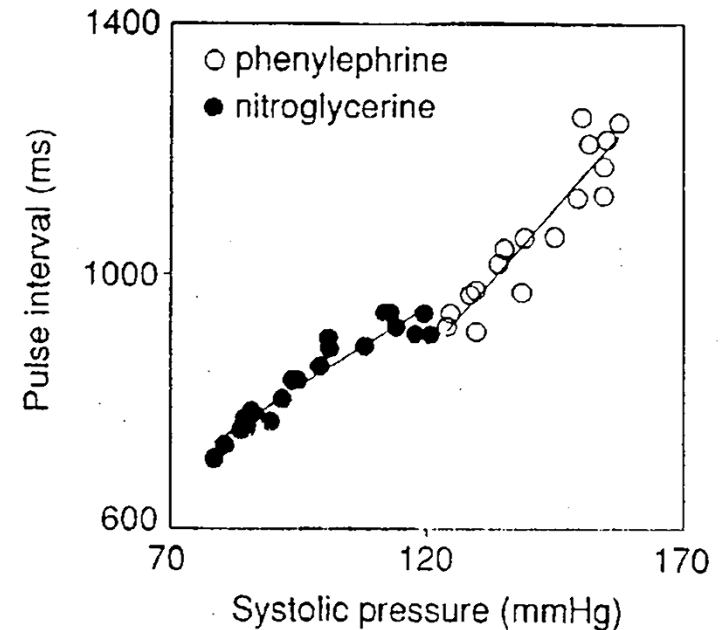


Evaluation of BRS

Standard(oxford) method:

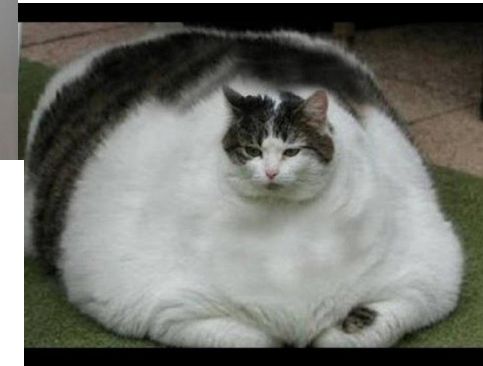
- Application of phenylephrine (vasoconstrictor)

Bolus injections of vasoactive drugs



Decreased BRS

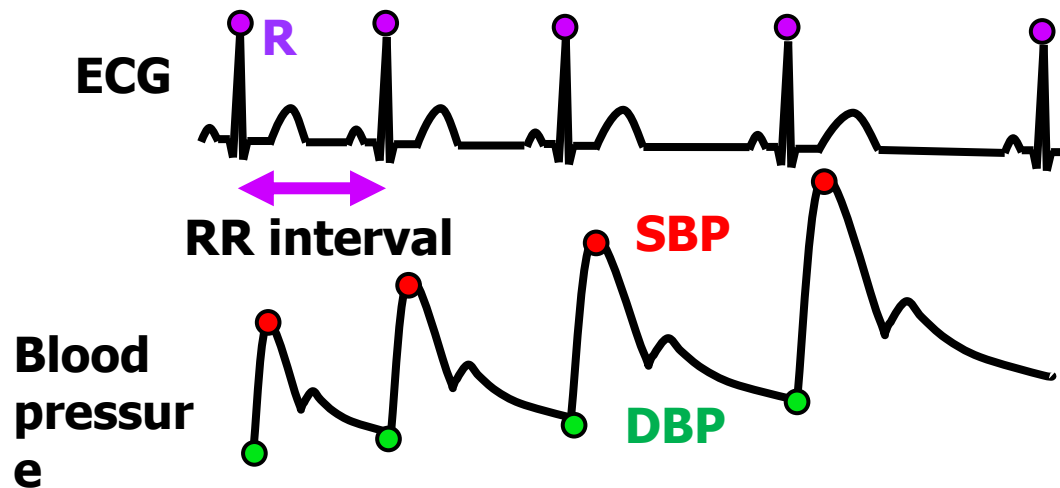
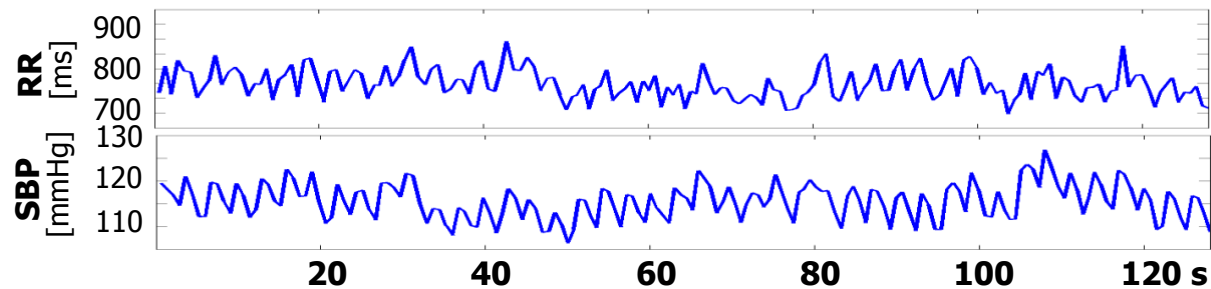
- Physiologically
 - psychic stress – increased sympathetic activity
 - Physical exercise – increased sympathetic activity
 - In old age
- Pathologically
 - hypertension – decreased baroreceptor sensitivity (atherosclerosis, increased arterial stiffness)
 - diabetes – neuropathy of autonomic nervous 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



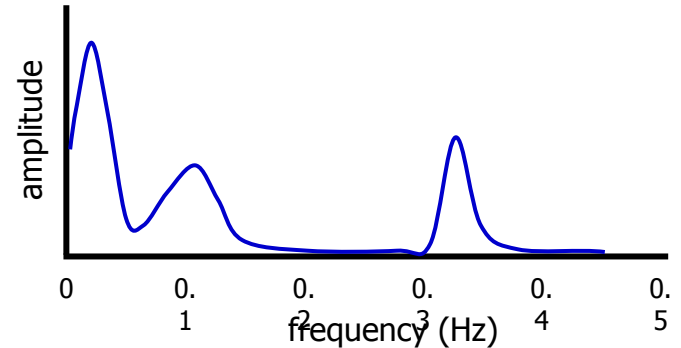
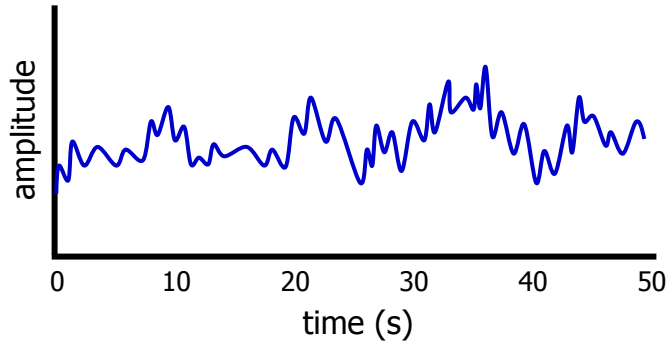
Frequency domain methods – spectral analysis

Time series
Signal in time domain



Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies



Frequency domain methods – spectral analysis

Time series

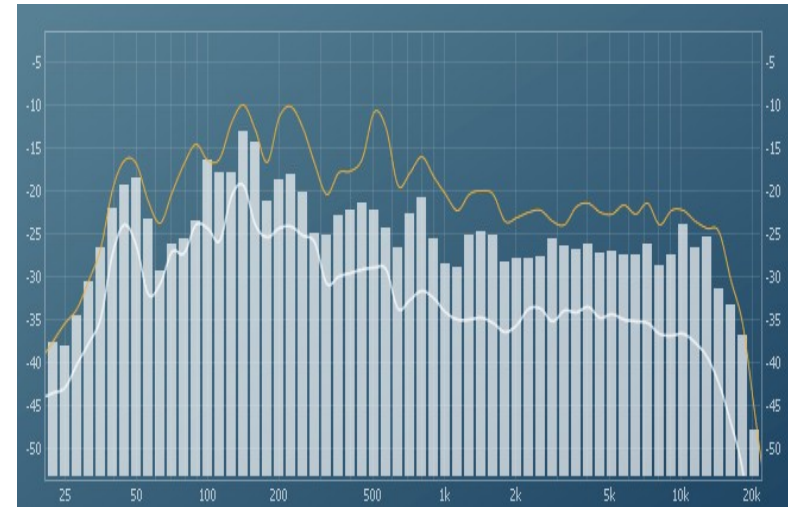
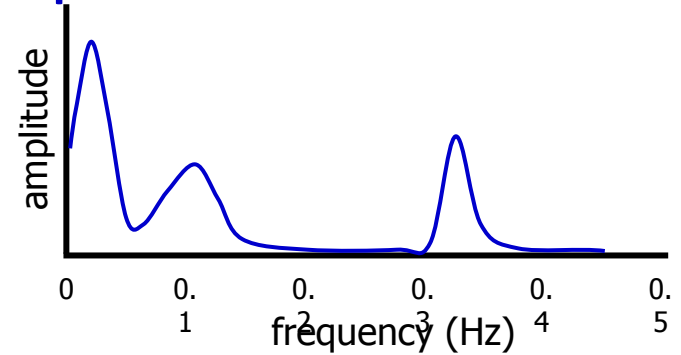
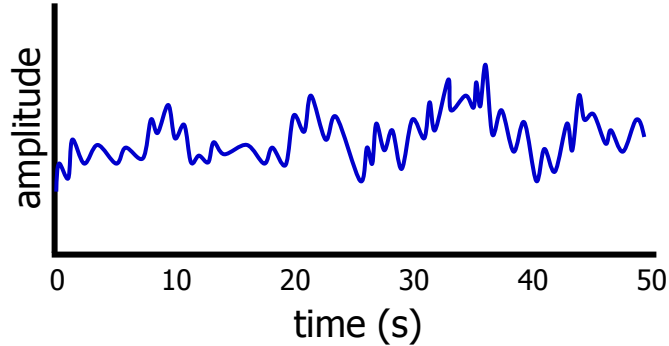
Signal in time domain



Spectrum

Signal in frequency domain

Signal is decomposed in individual frequencies

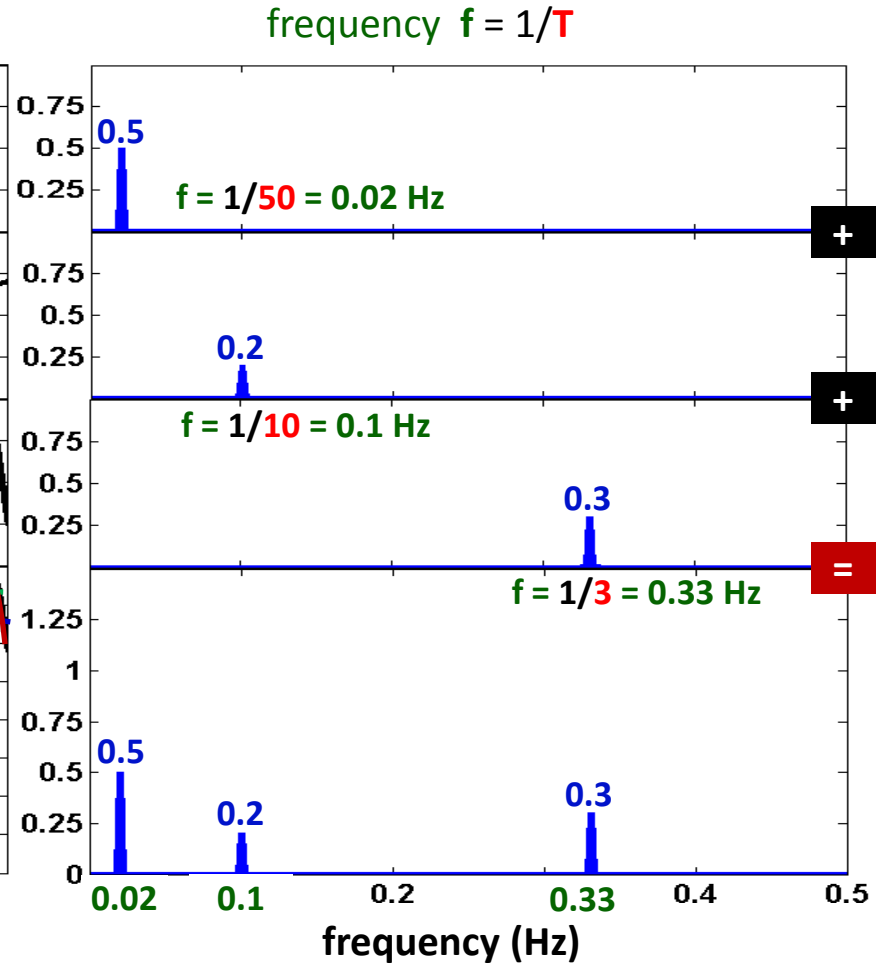
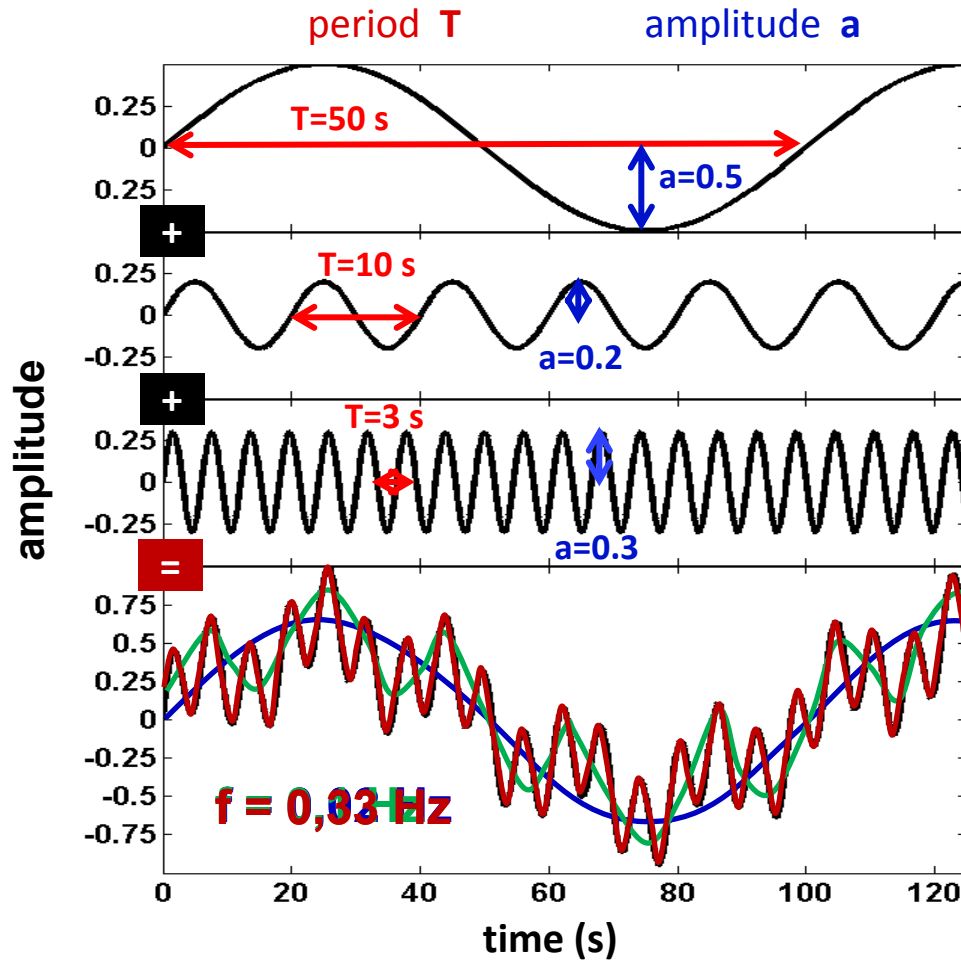




How the spectrum is formed?

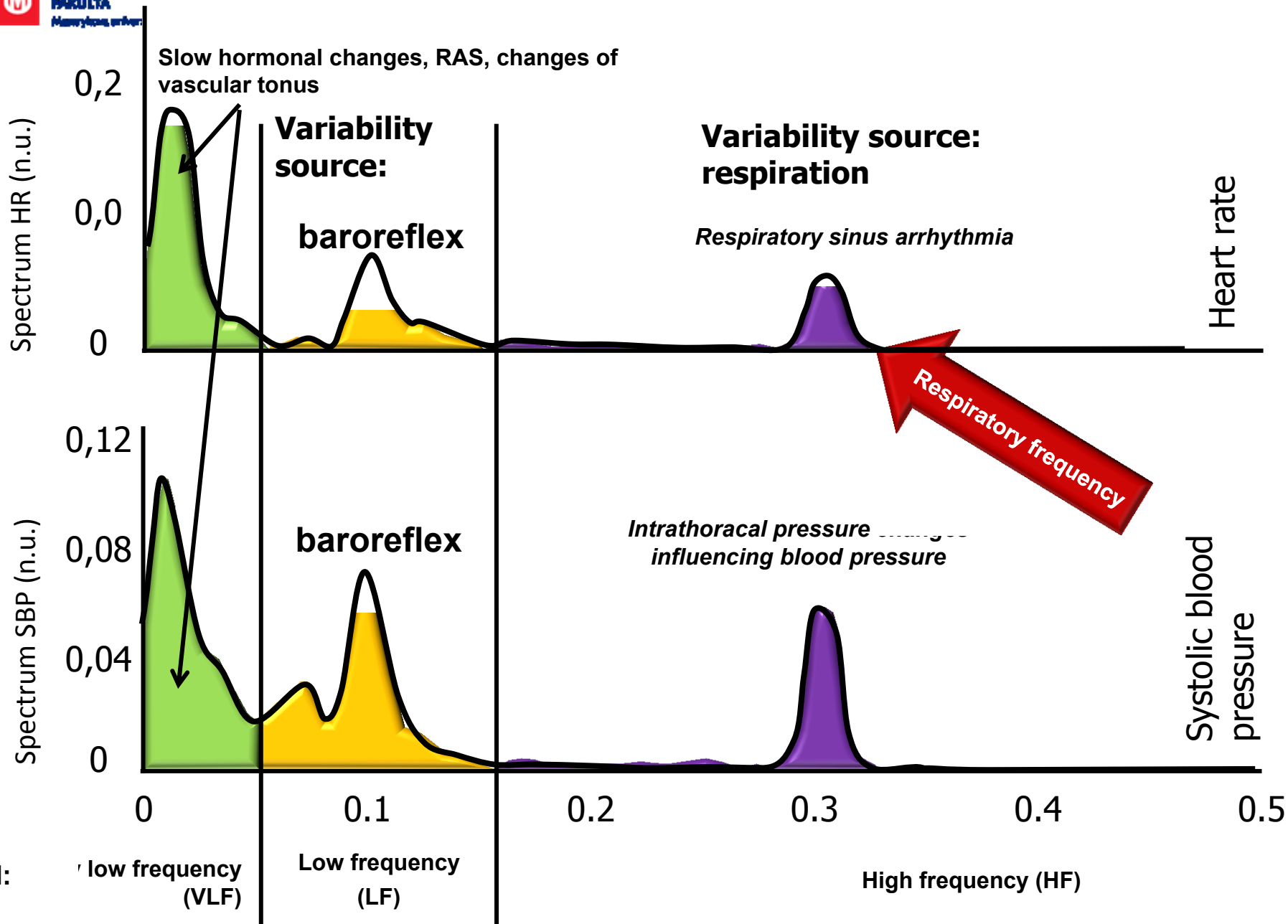
Spectrum
Frequency domain

Time domain





Physiological significance – frequency bands

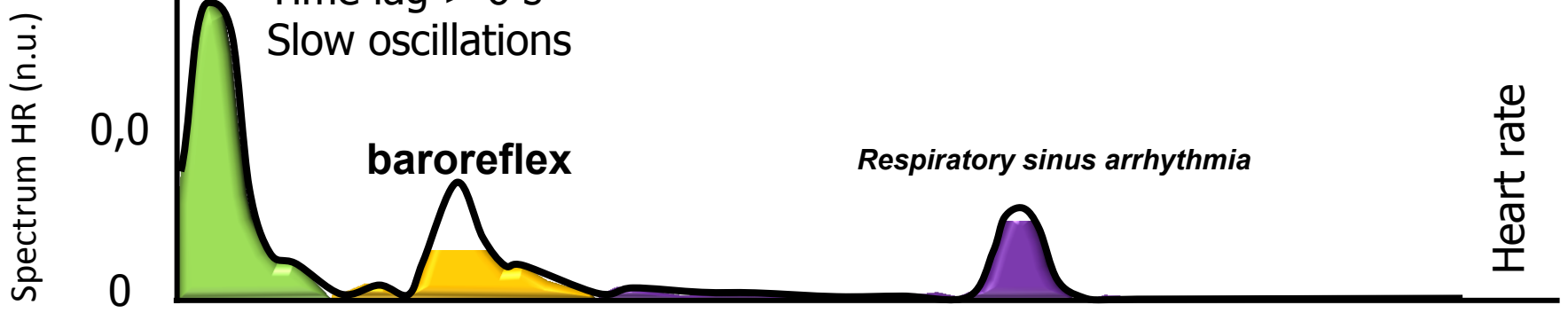


← **parasympathetic activity**

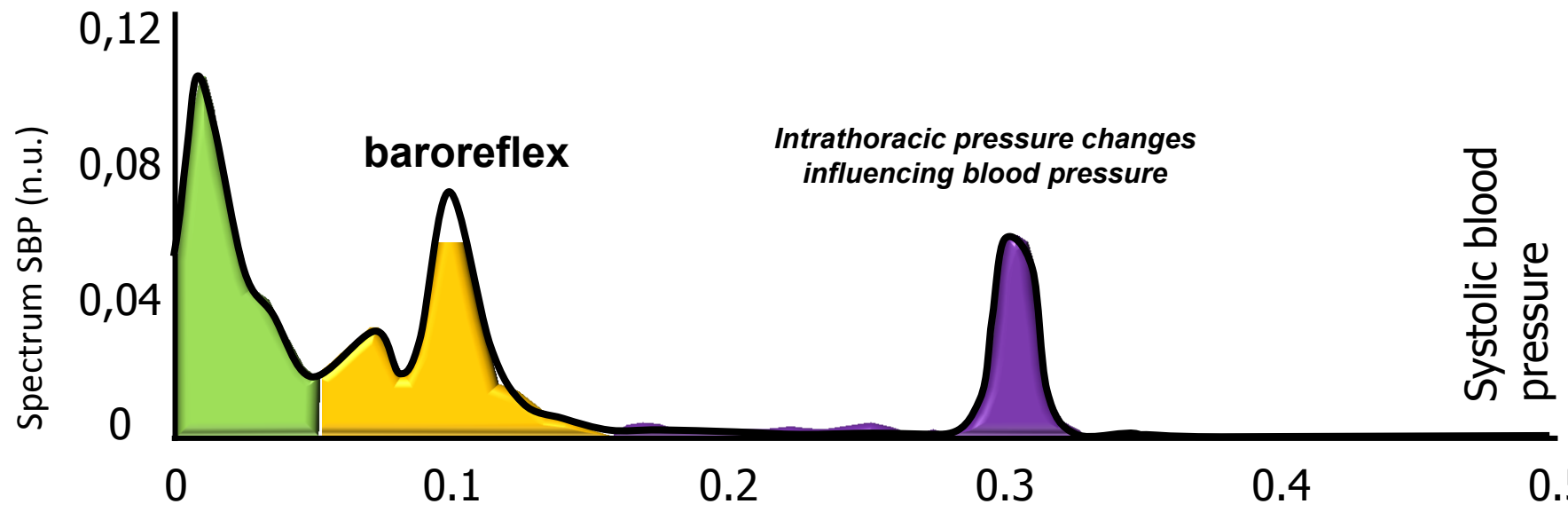
← **Sympathetic activity**

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

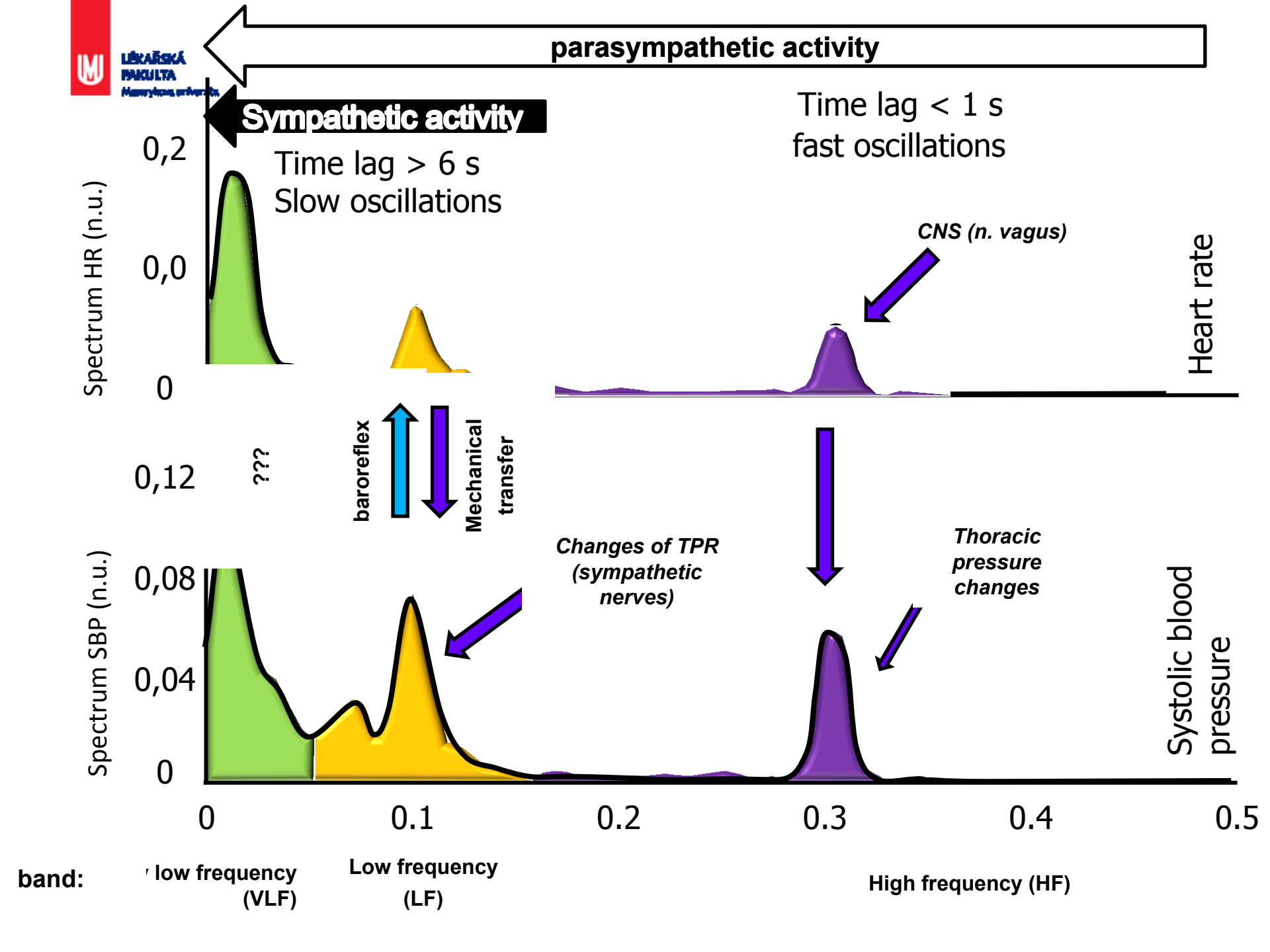
0 0.1 0.2 0.3 0.4 0.5

band:

low frequency (VLF)

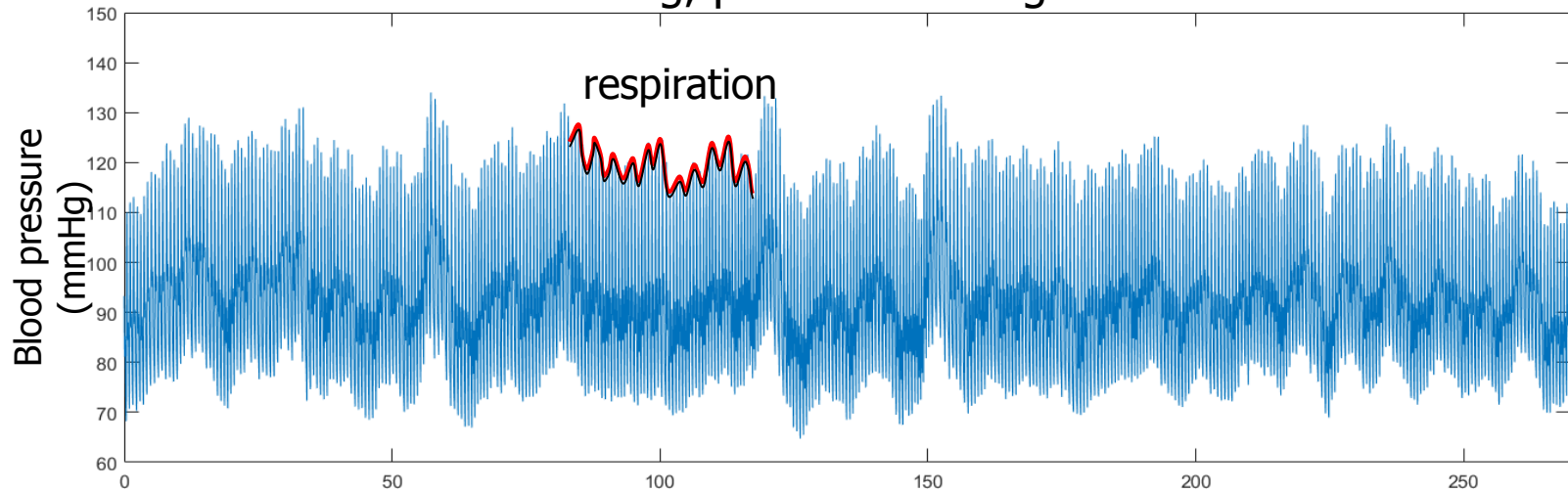
Low frequency (LF)

High frequency (HF)

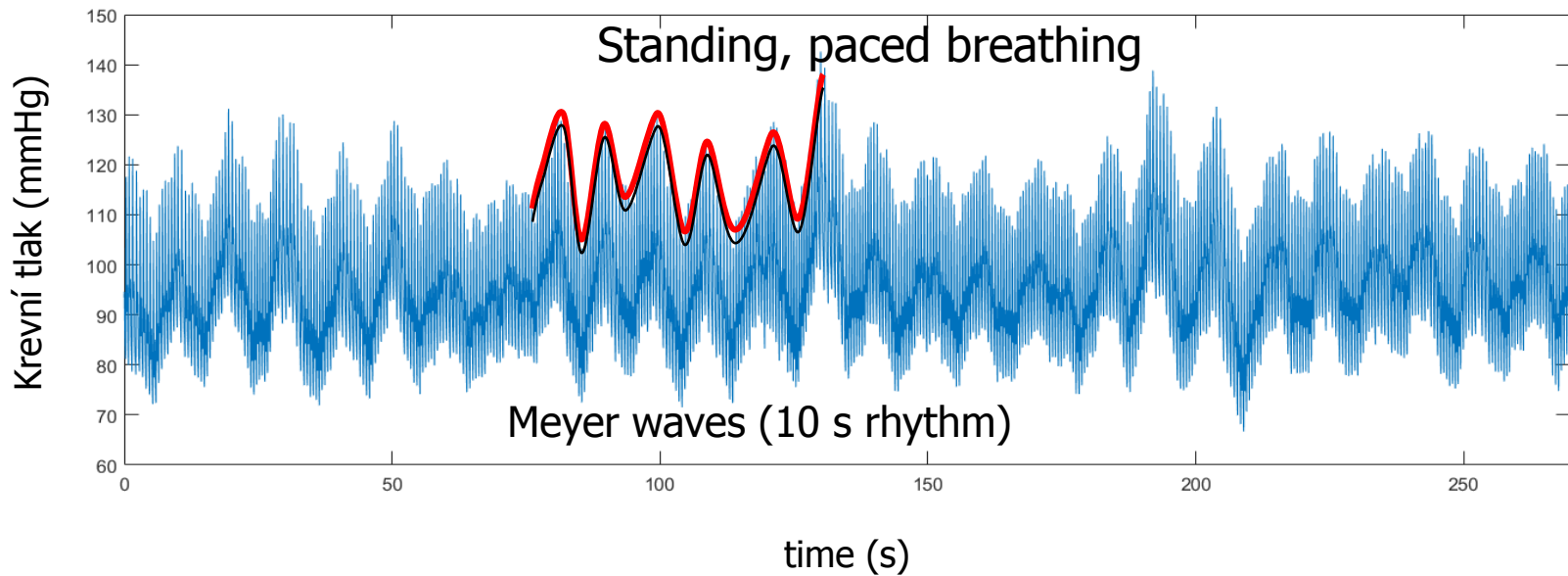


Blood pressure signal (270 s)

Sitting, paced breathing

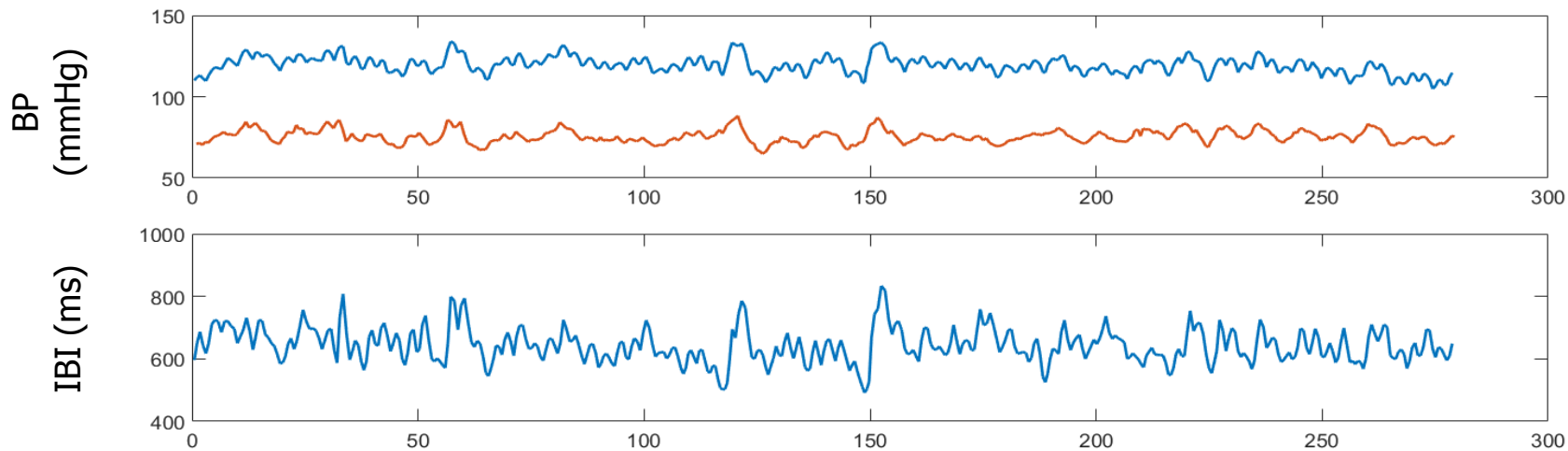


Standing, paced breathing

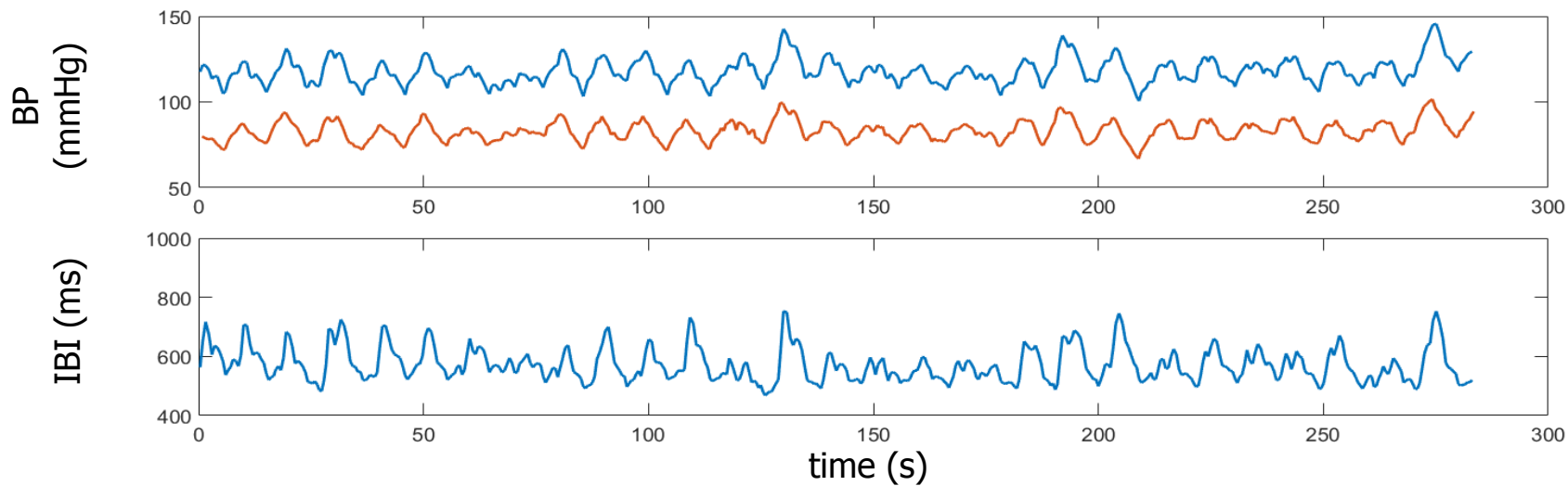


sequences of SBP, DBP and inter-beat intervals

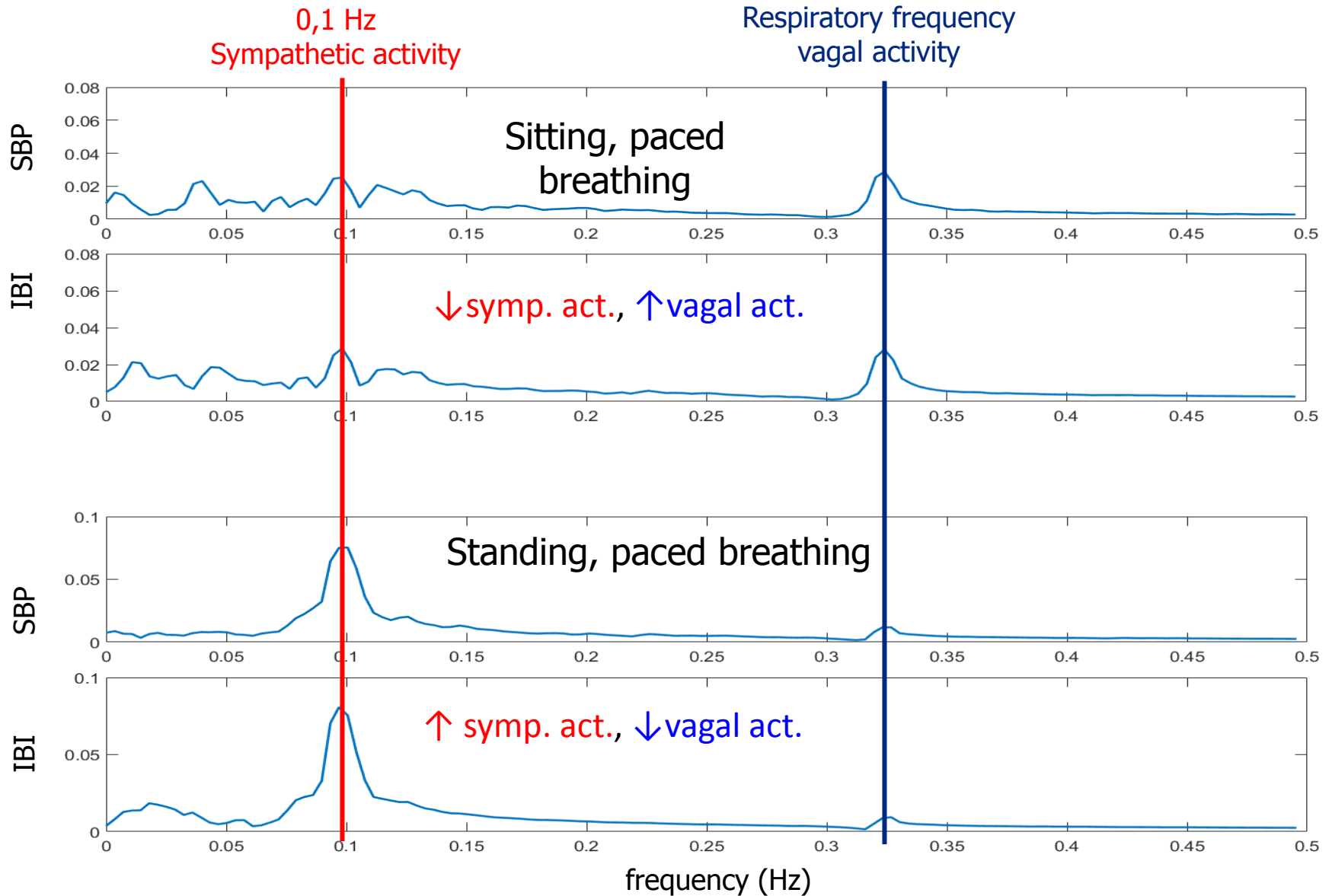
Sitting, paced breathing



Standing, paced breathing

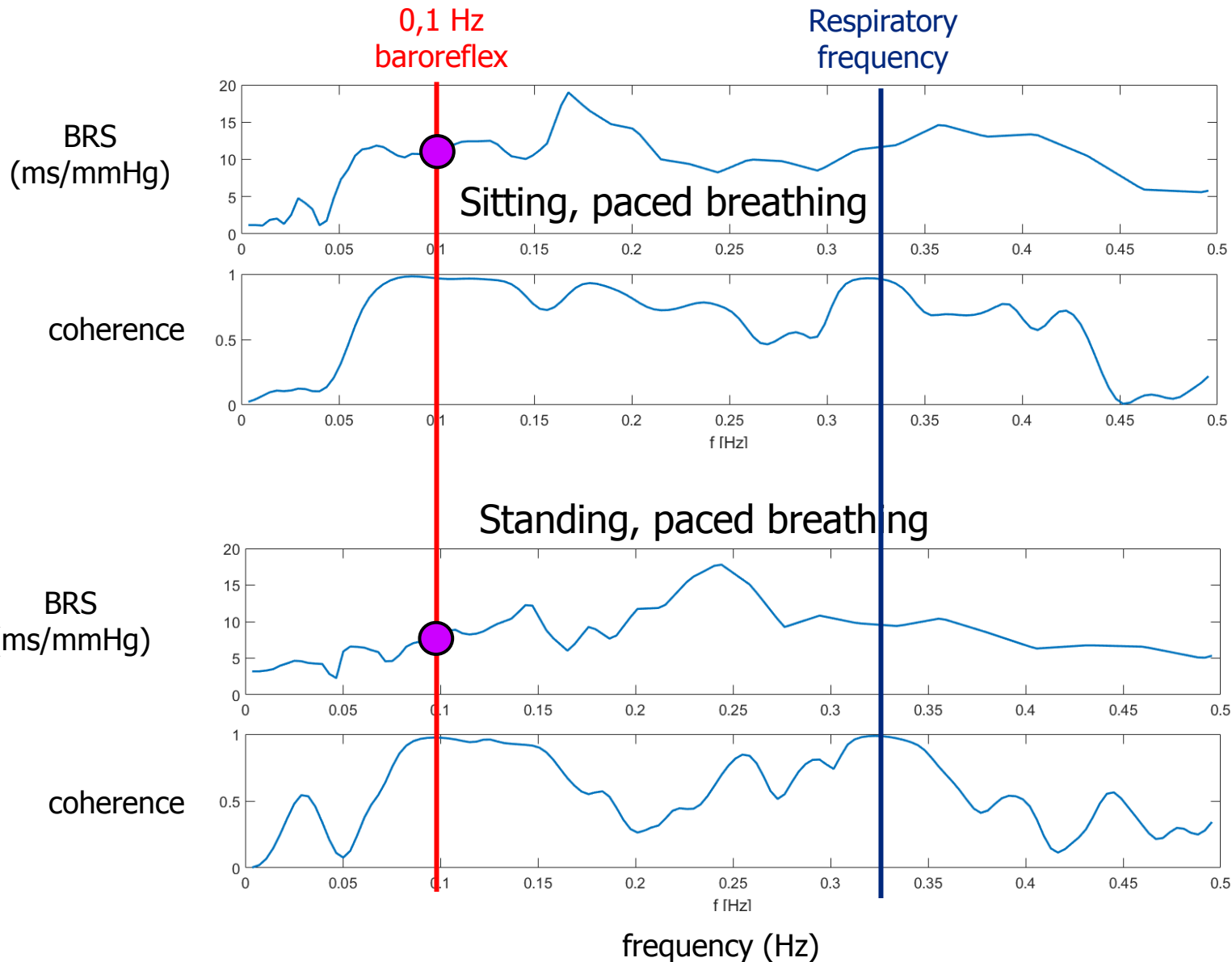


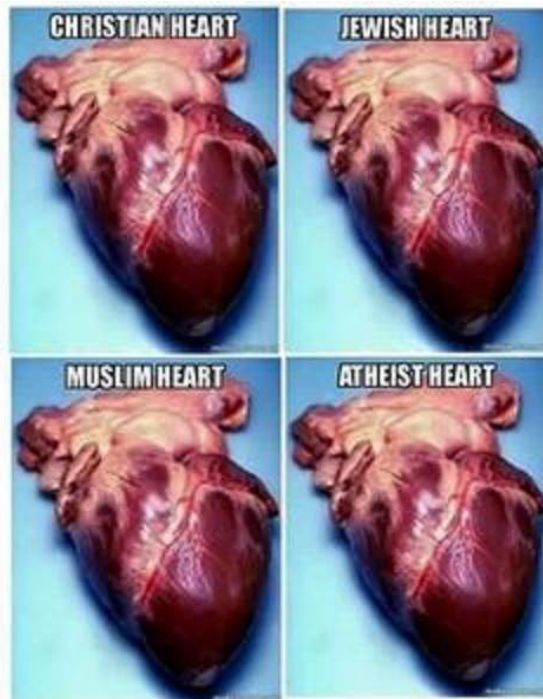
Spectra of SBP and IBI



Coherence a BRS

coherence: synchronization between signals (correlation on particular frequency)





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