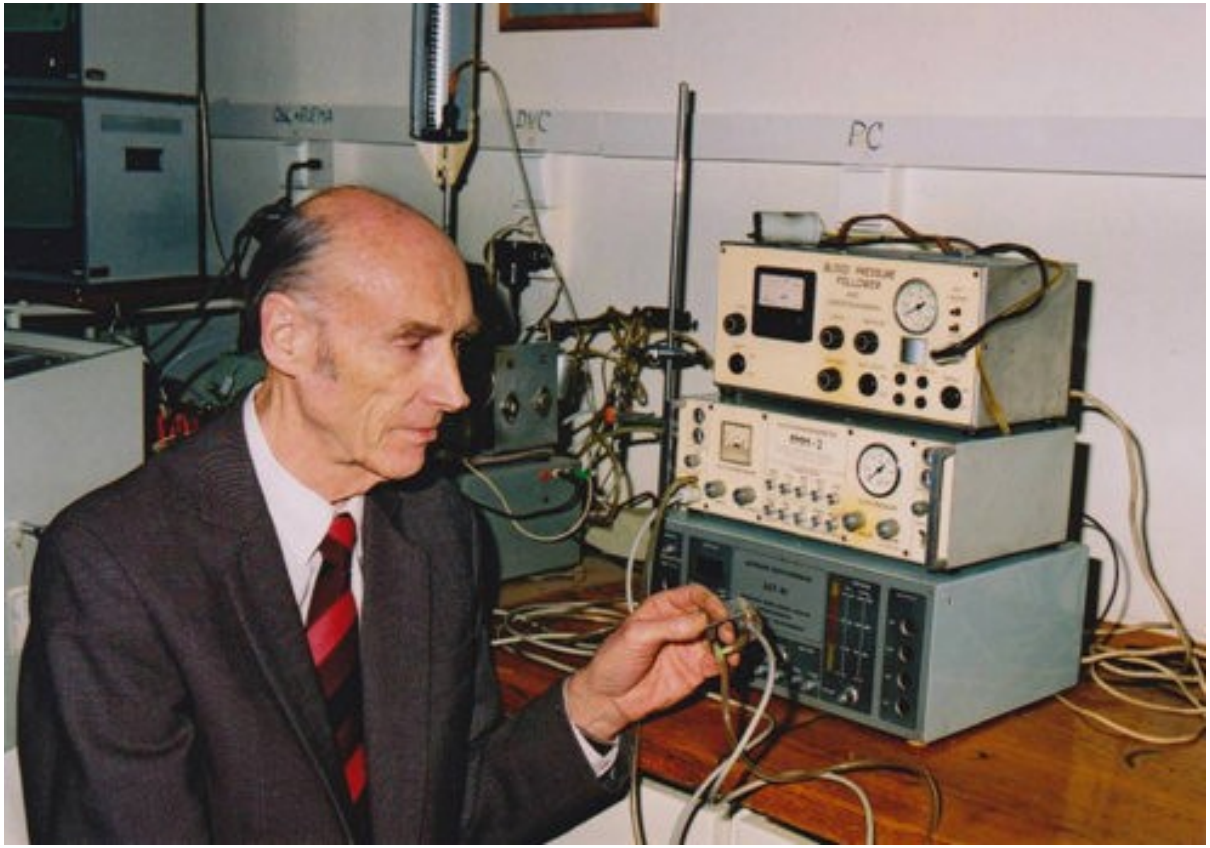
LÉKAŘSKÁ FAKULTA
Masarykova univerzita

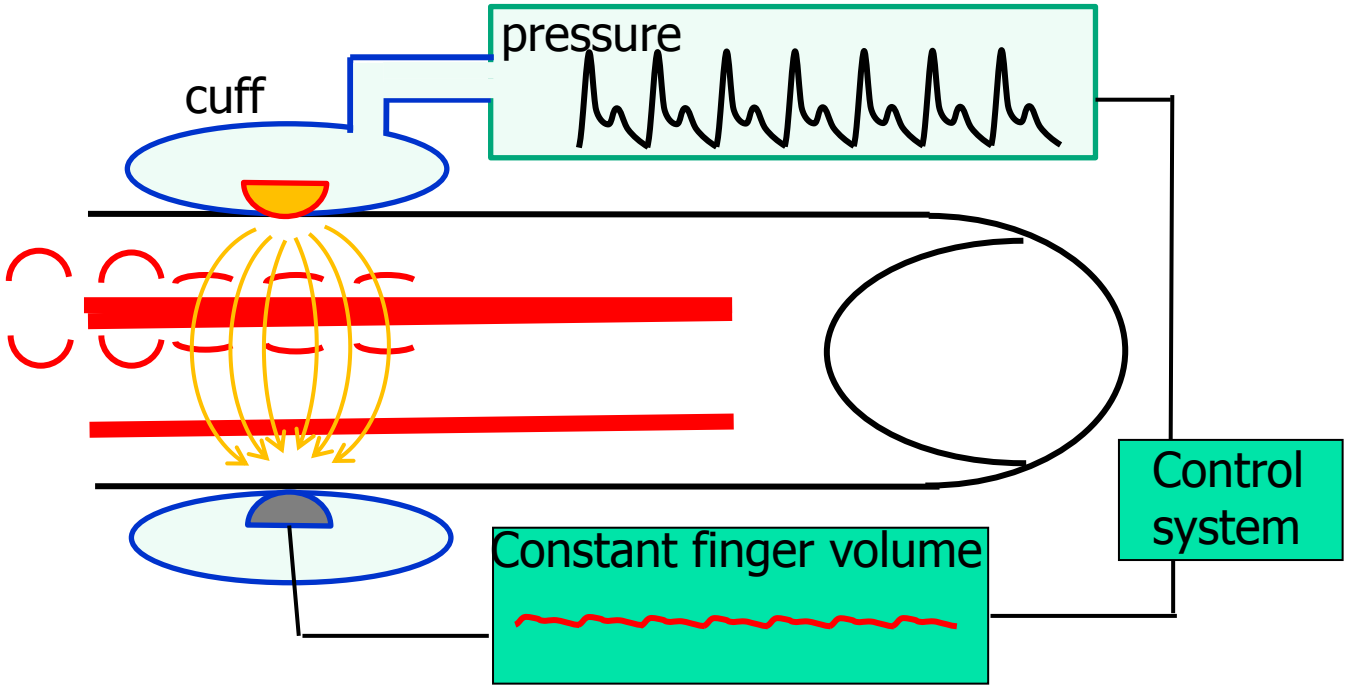
Photoplethysmographic blood presure measurement

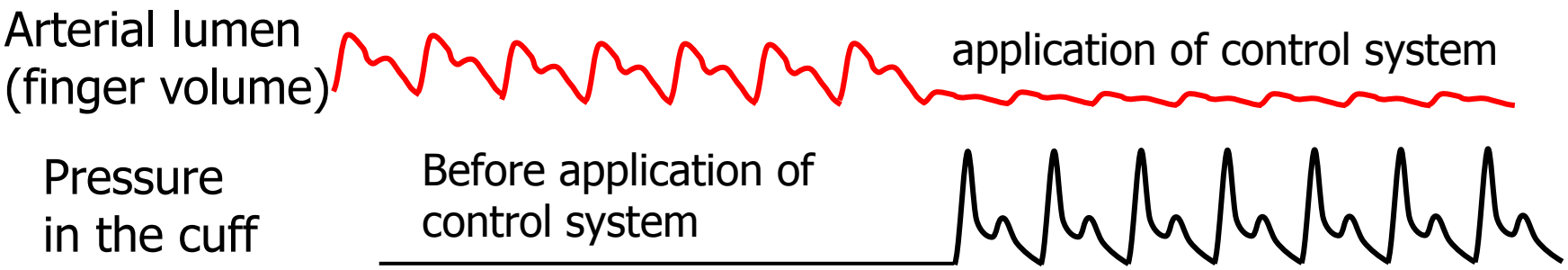
Peňáz´s method, volume-clamp method



Principle of continual blood pressure measurement

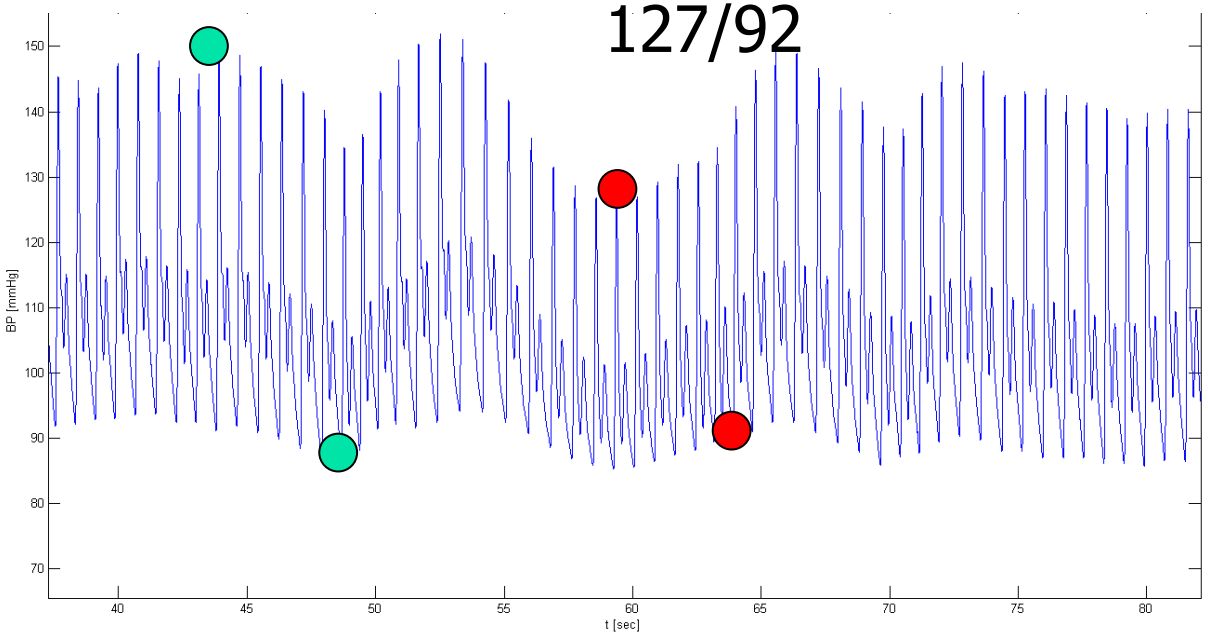
Control system:
Correction of the pressure in the finger cuff according to the arterial lumen changes.
Aim: maintaining of constant arterial lumen through pressure changes in the cuff.



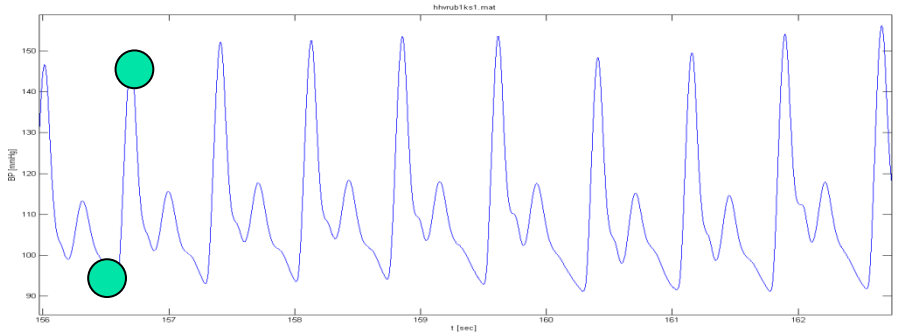


150/90

127/92



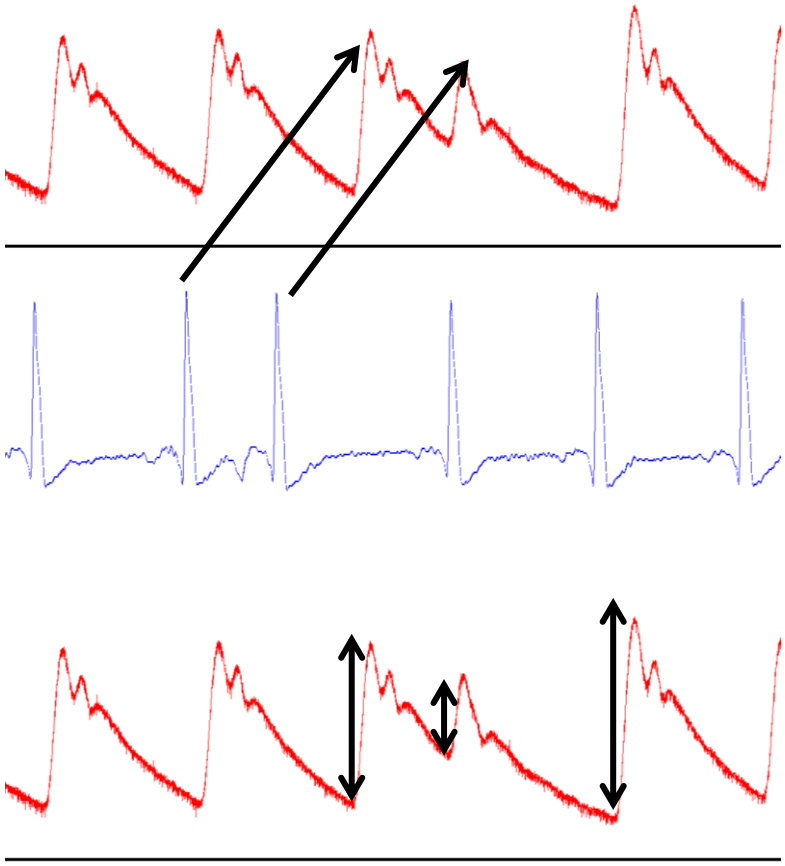
SBP



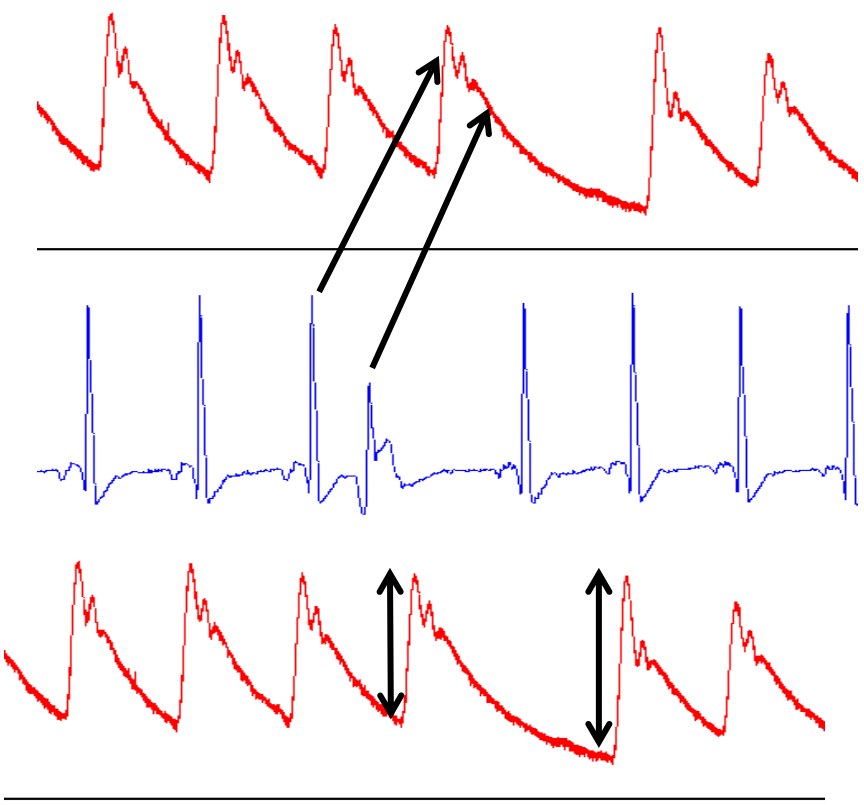
DBP

Extrasystoles

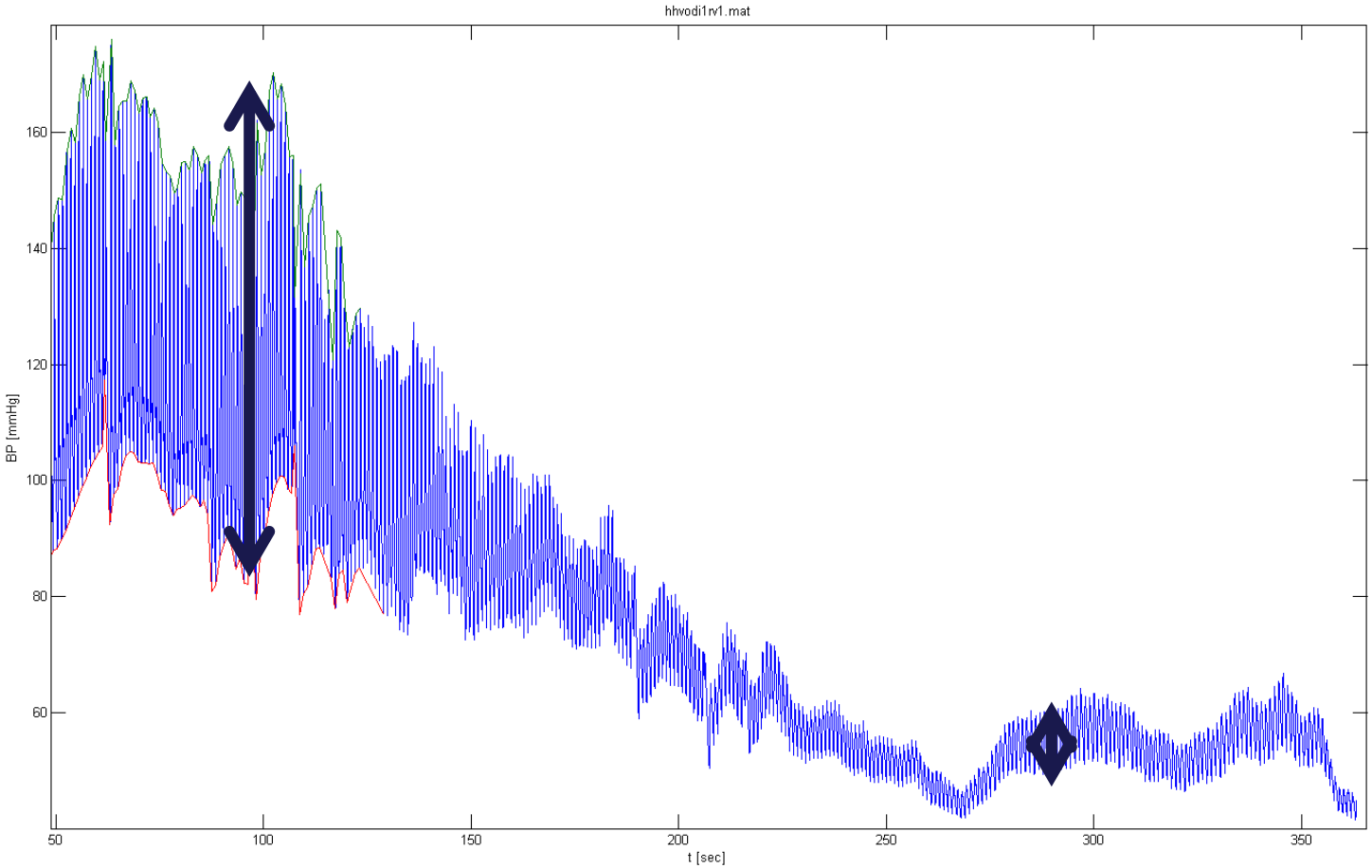
supraventricular



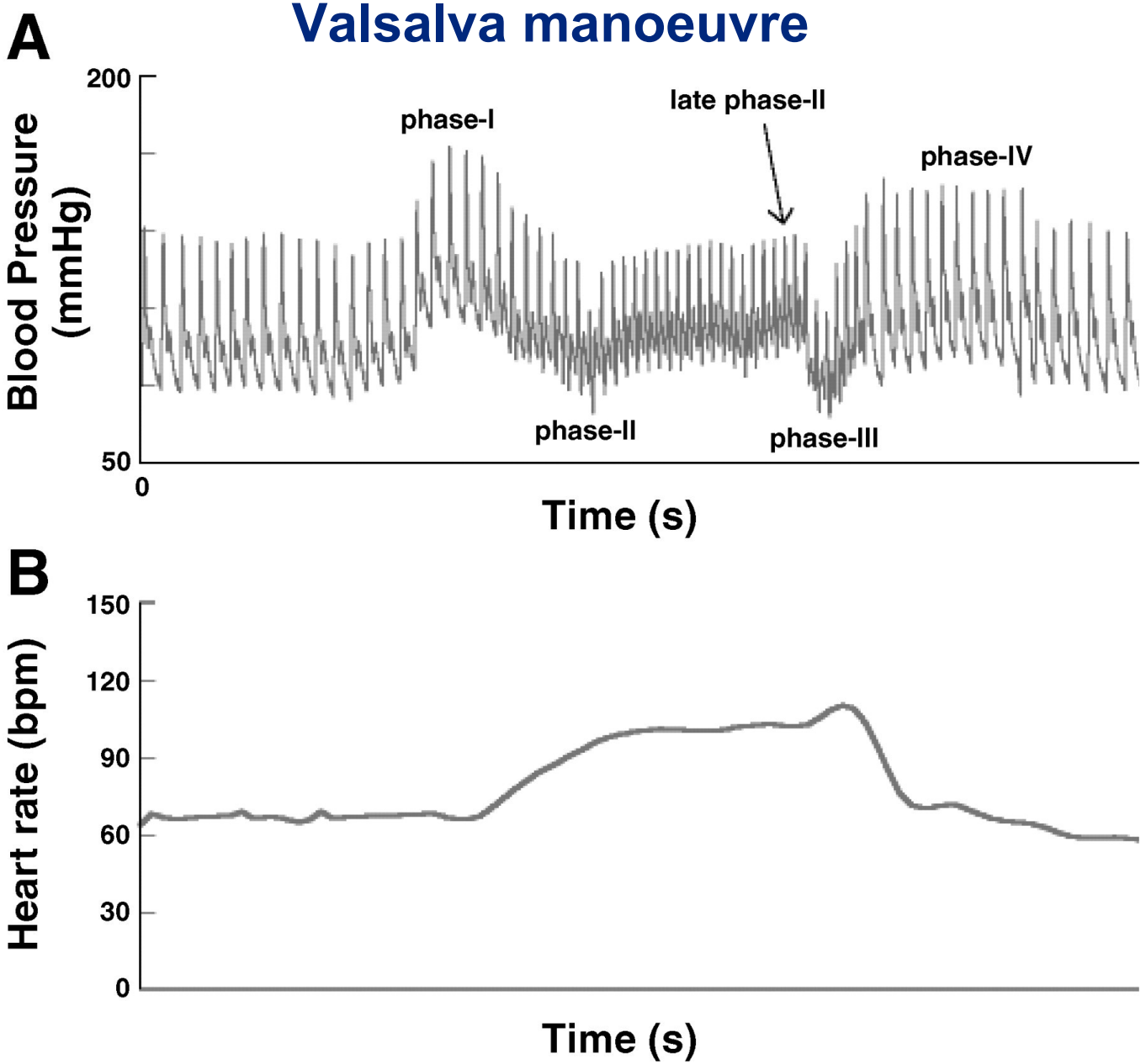
ventricular



Orthostatic hypotension



Valsalva manoeuvre



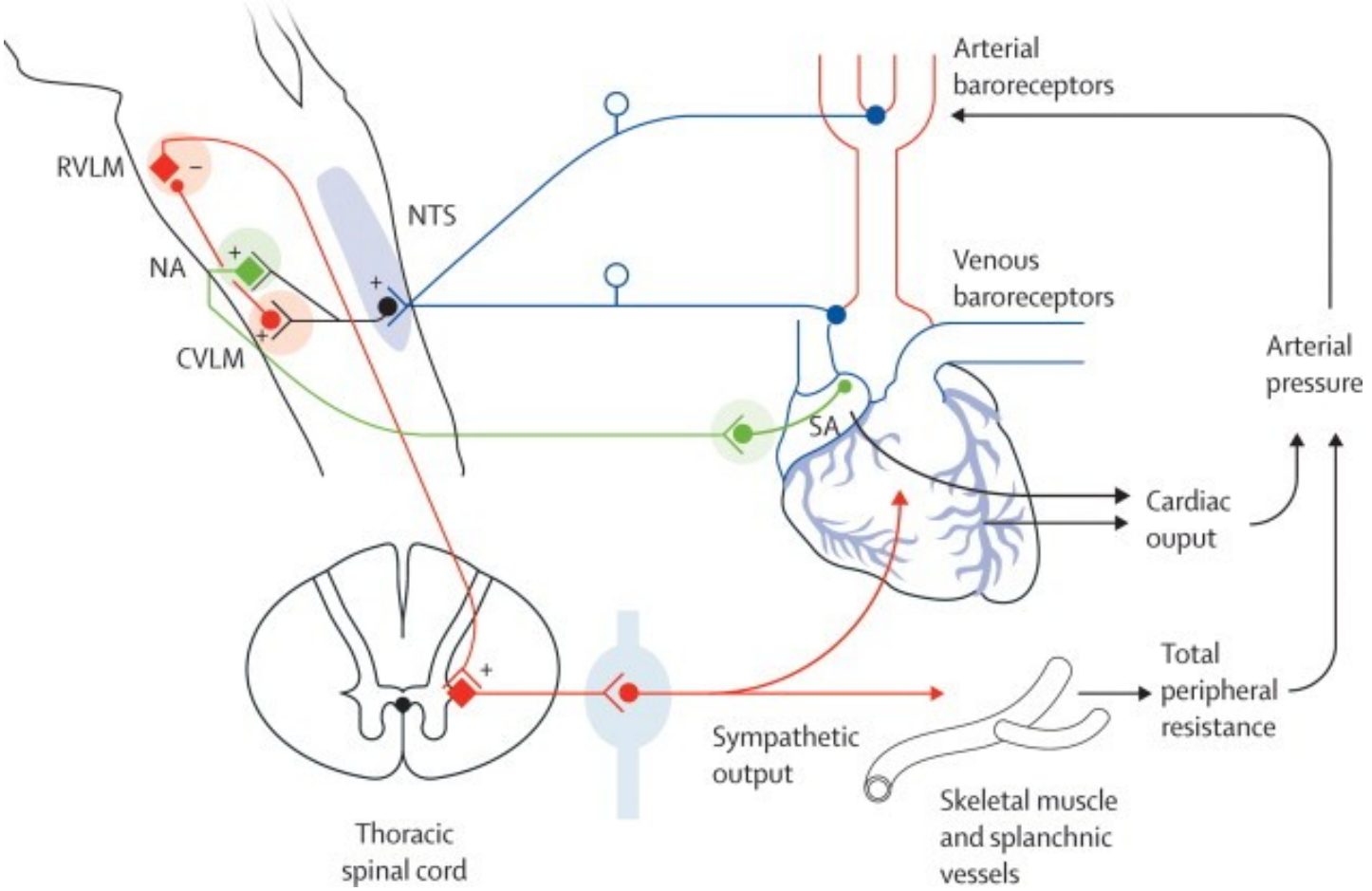
See videos:

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

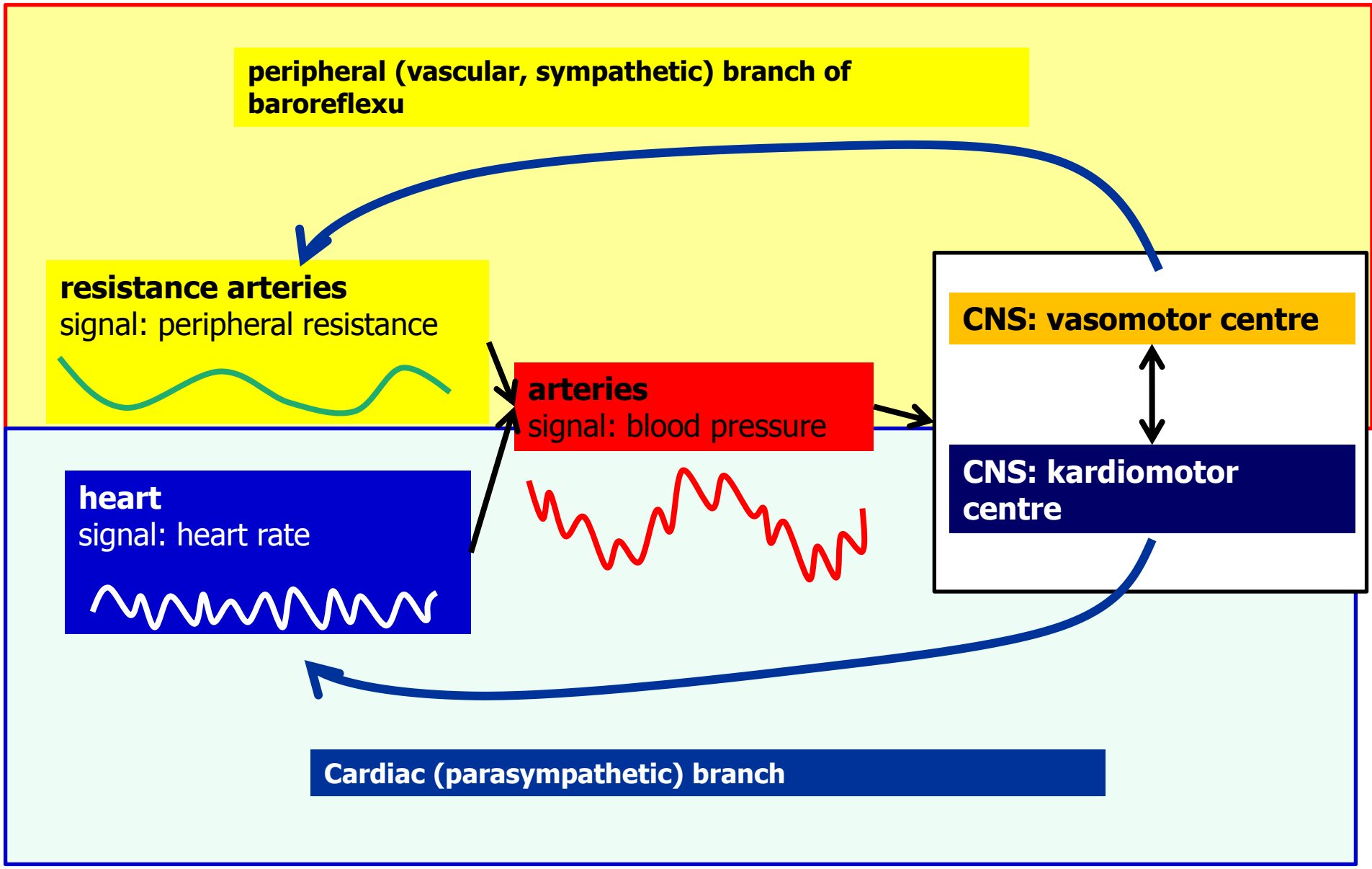
BP changes during smoking
https://www.youtube.com/watch?v=J5vPJPfNH3k&t=1s

Baroreflex

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



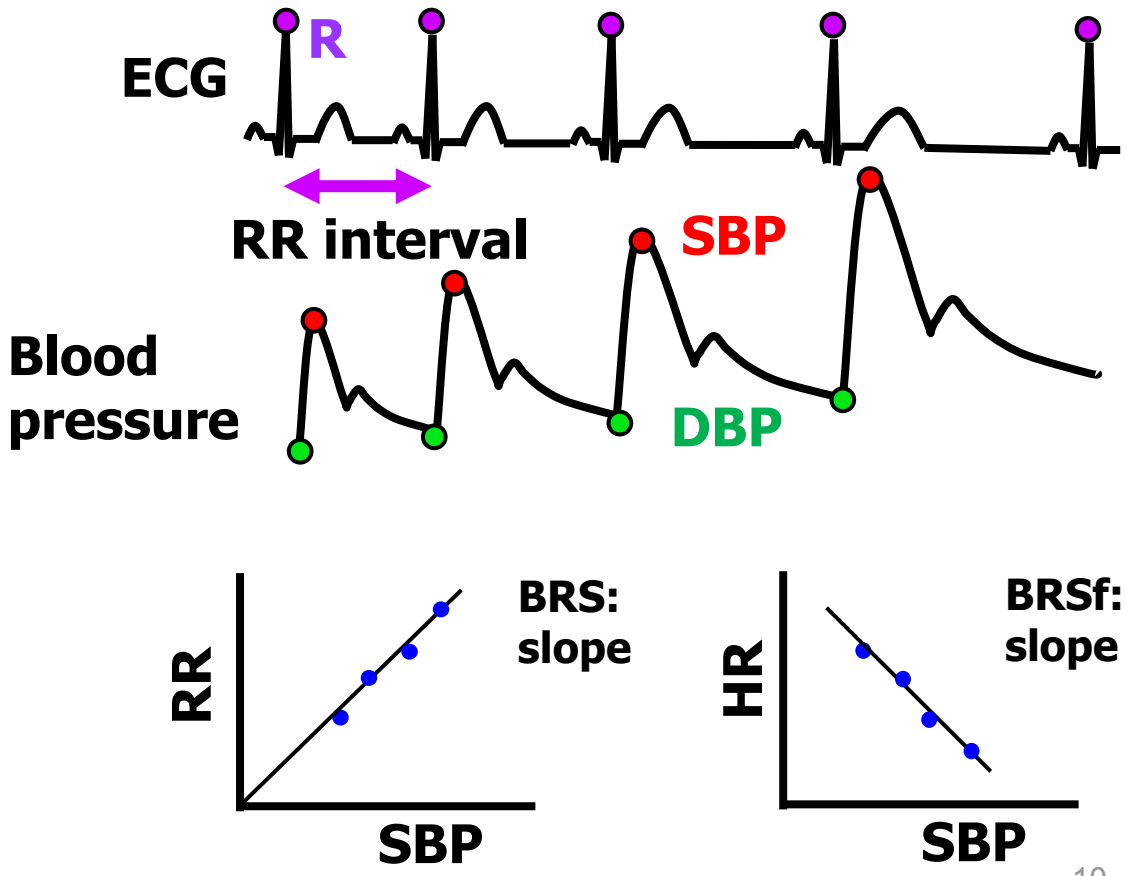
Baroreflex


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

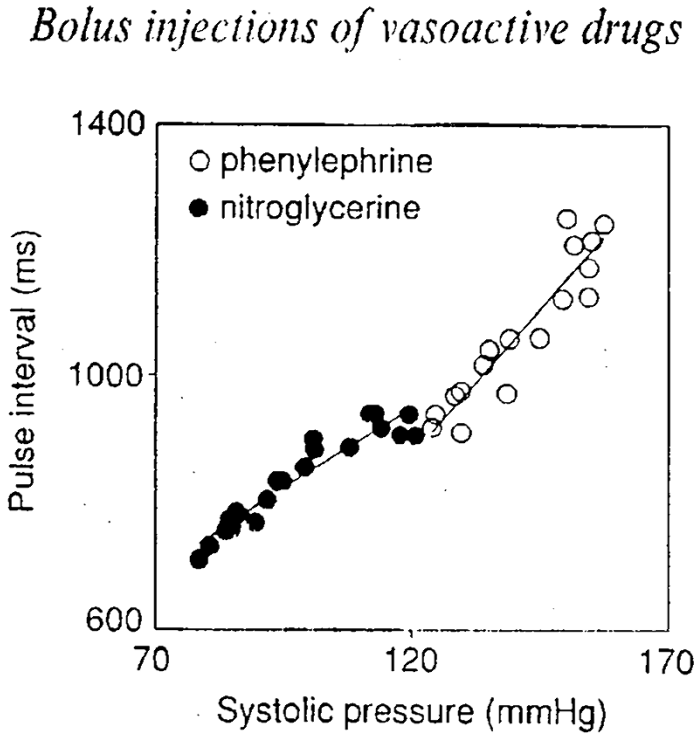
BRS: change of cardiac cycle caused by SBP change by 1 mmHg [ms/mmHg]

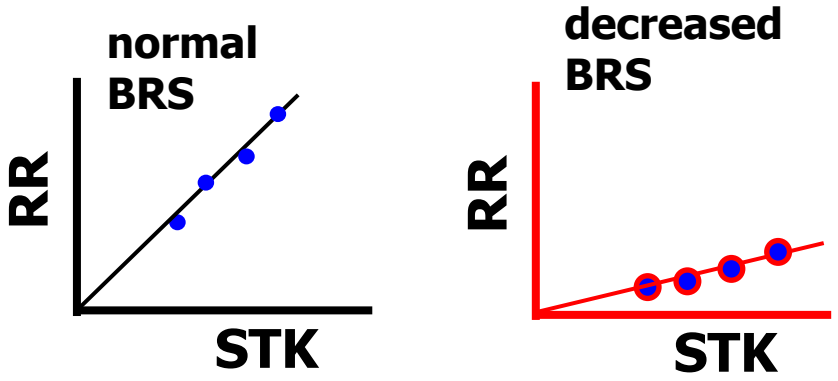


Evaluation of BRS

Standard(oxford) method:

- Application of phenylephrine (vasoconstrictor)





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



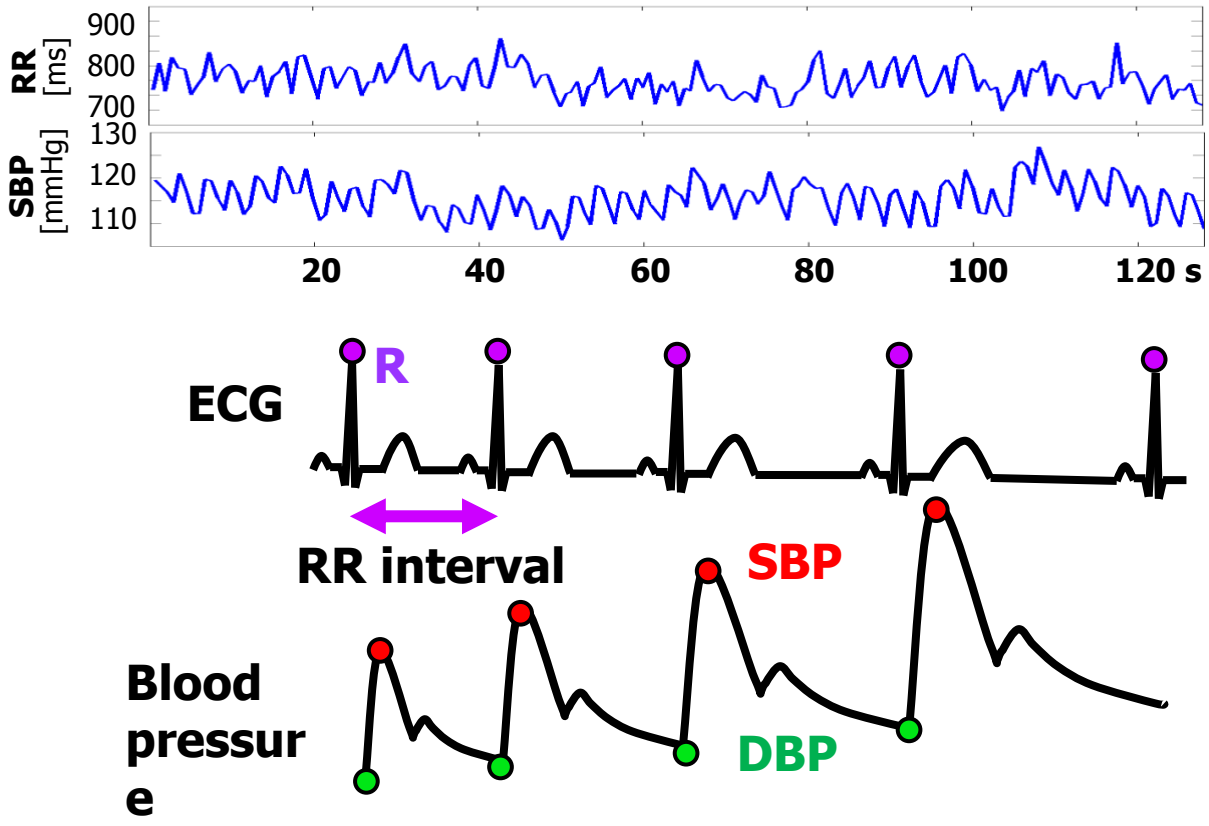




Signal: time series

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

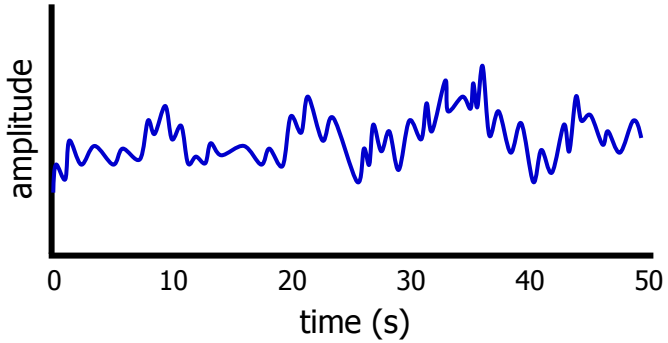


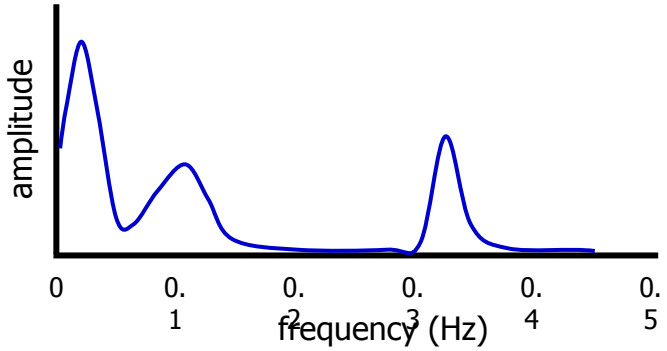
Frequency domain methods – spectral analysis

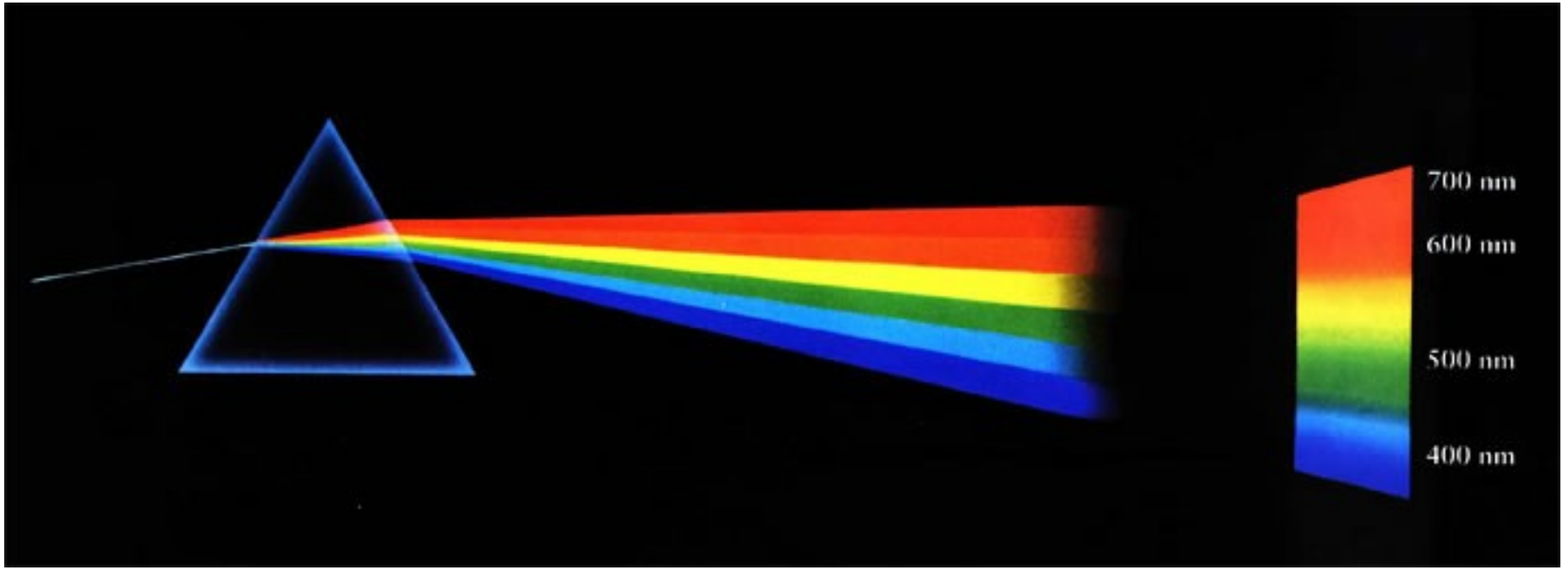
Time series
Signal in time domain

Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies





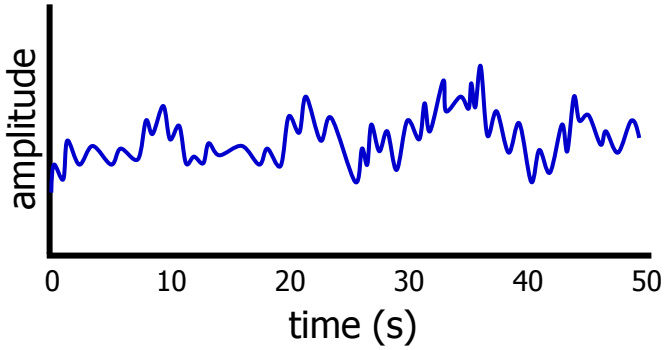


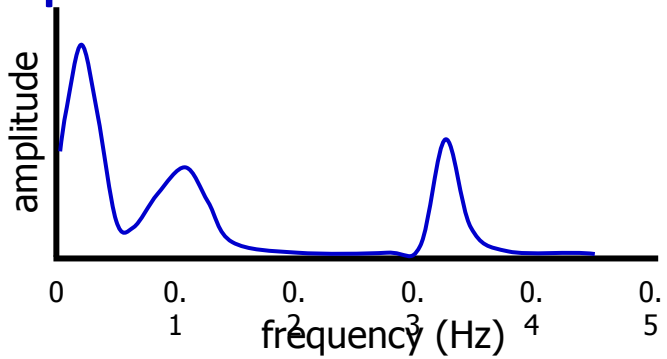
Frequency domain methods – spectral analysis

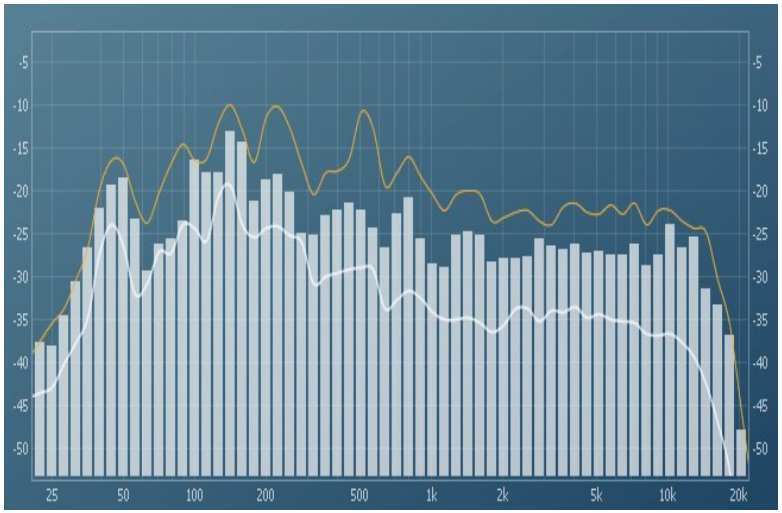
Time series
Signal in time domain

Spectrum
Signal in frequency domain

Signal is decomposed in individual frequencies



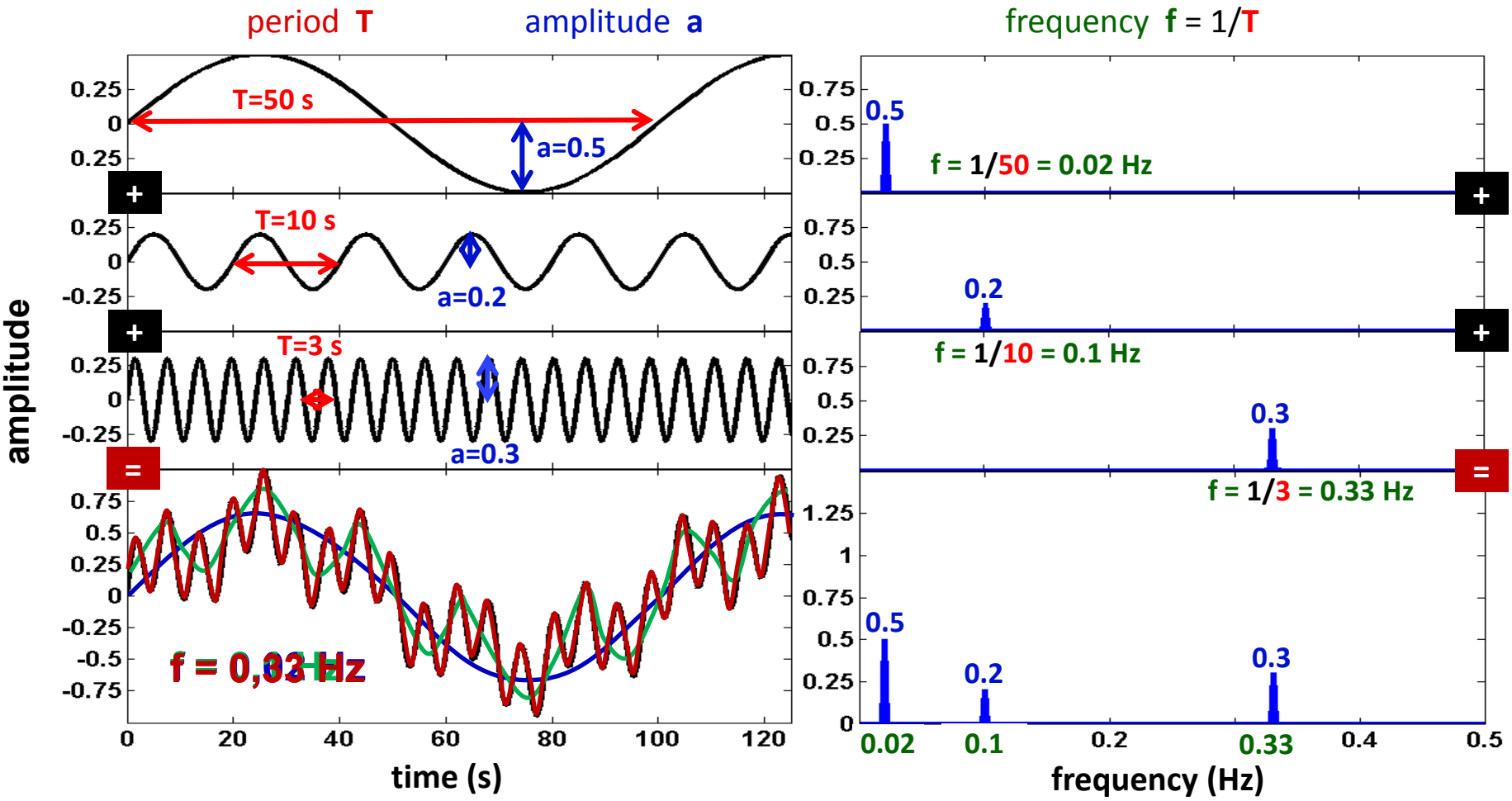




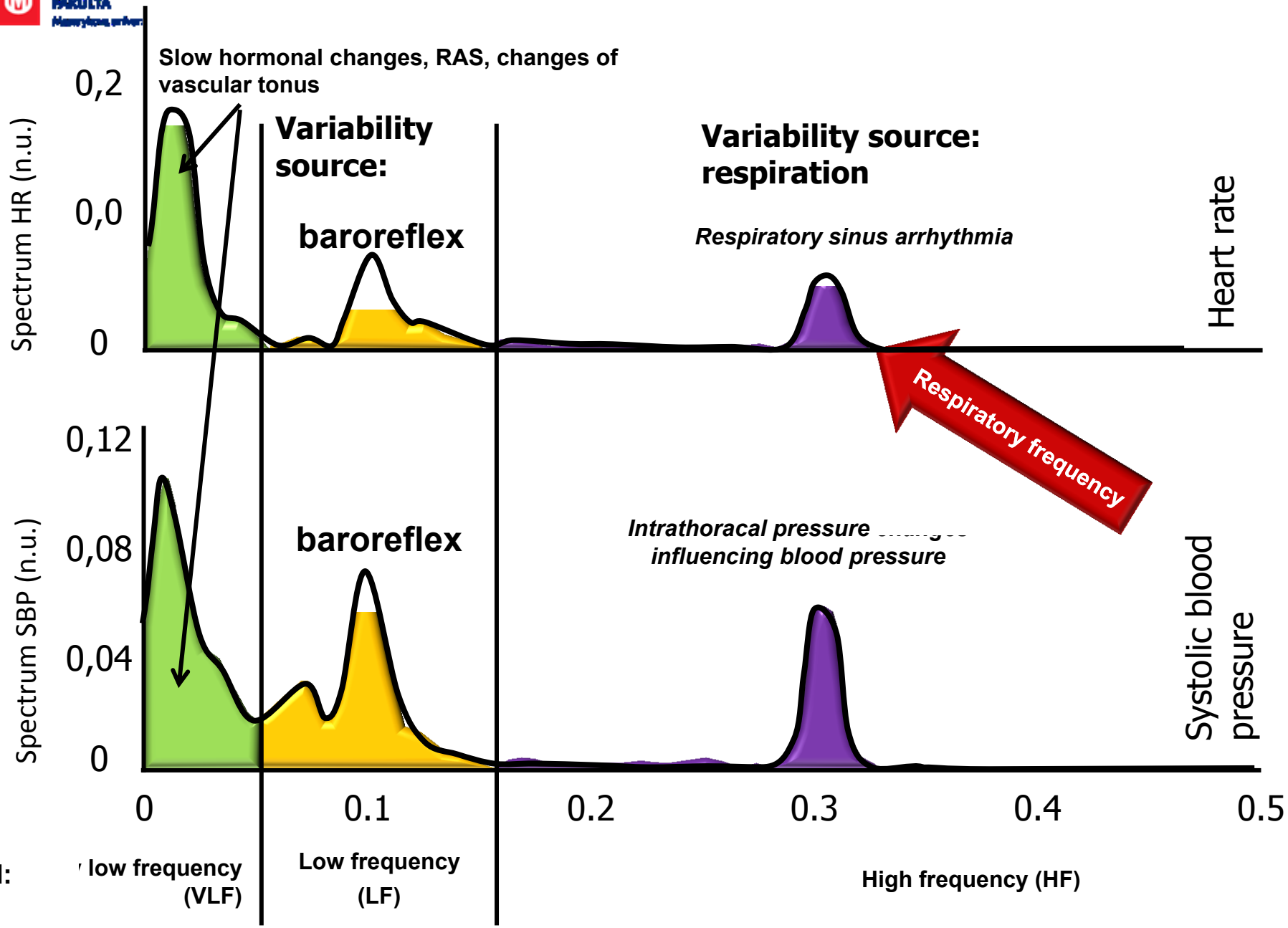
How the spectrum is formed?

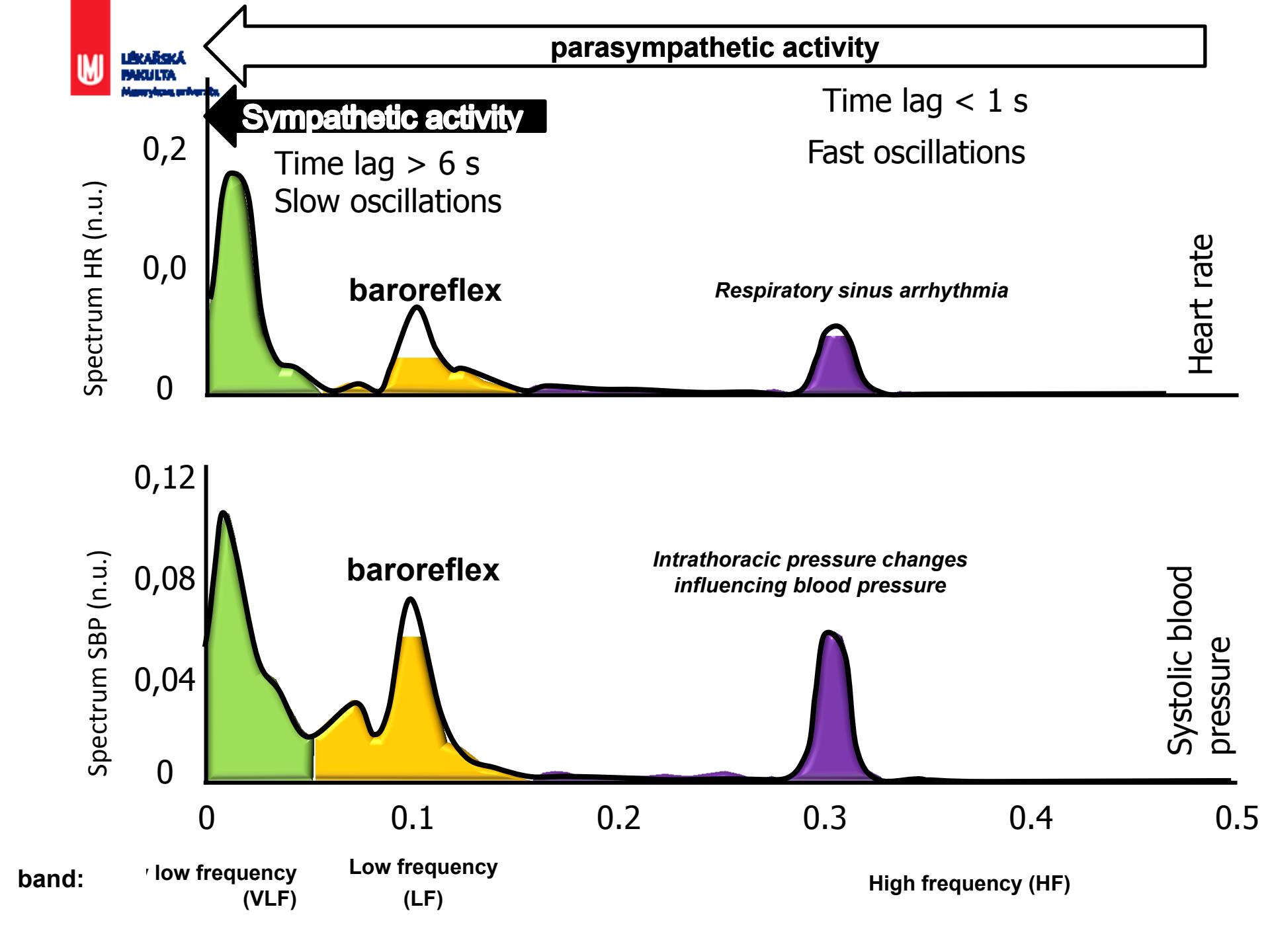
Time domain

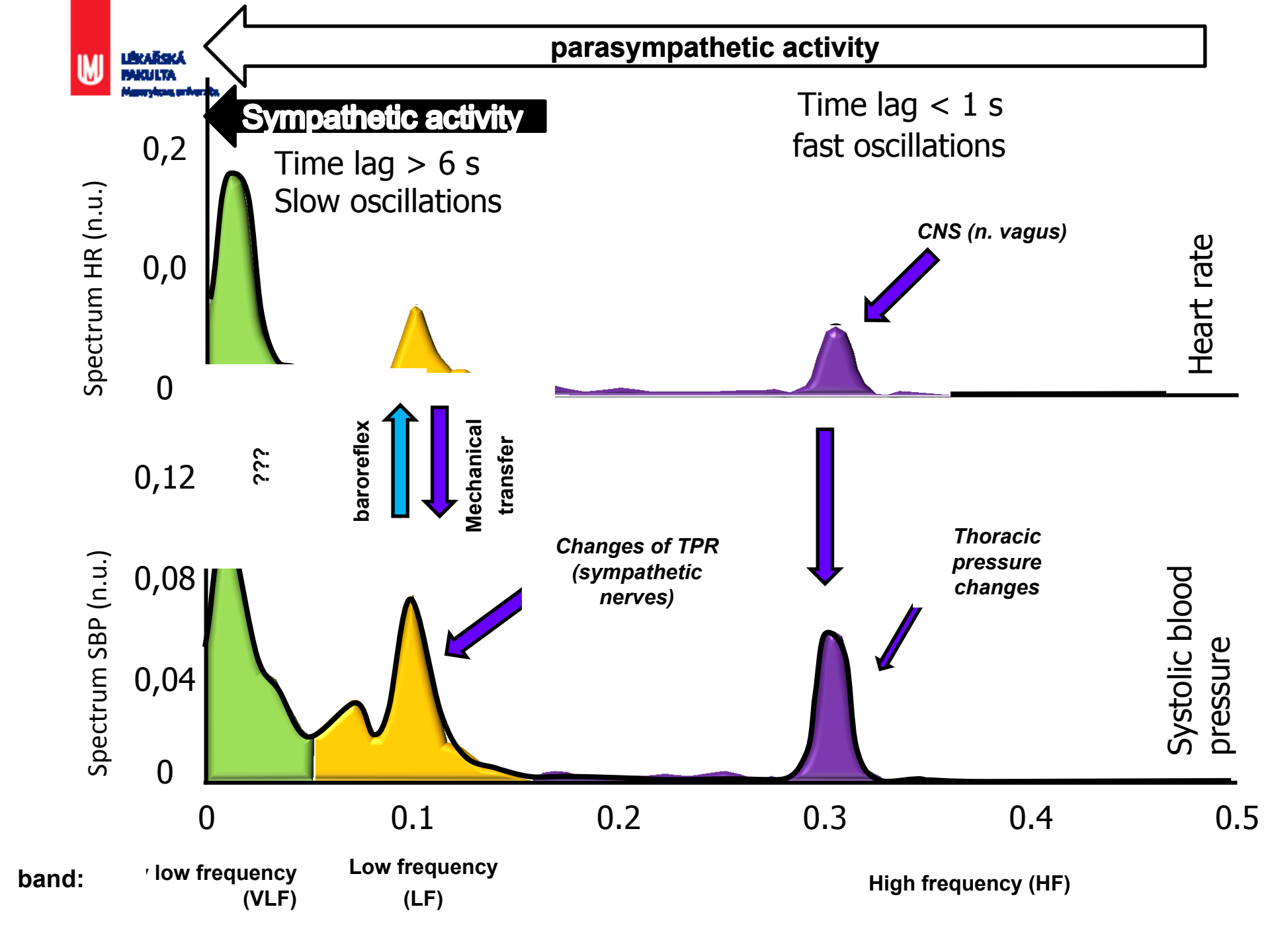
Spectrum
Frequency domain



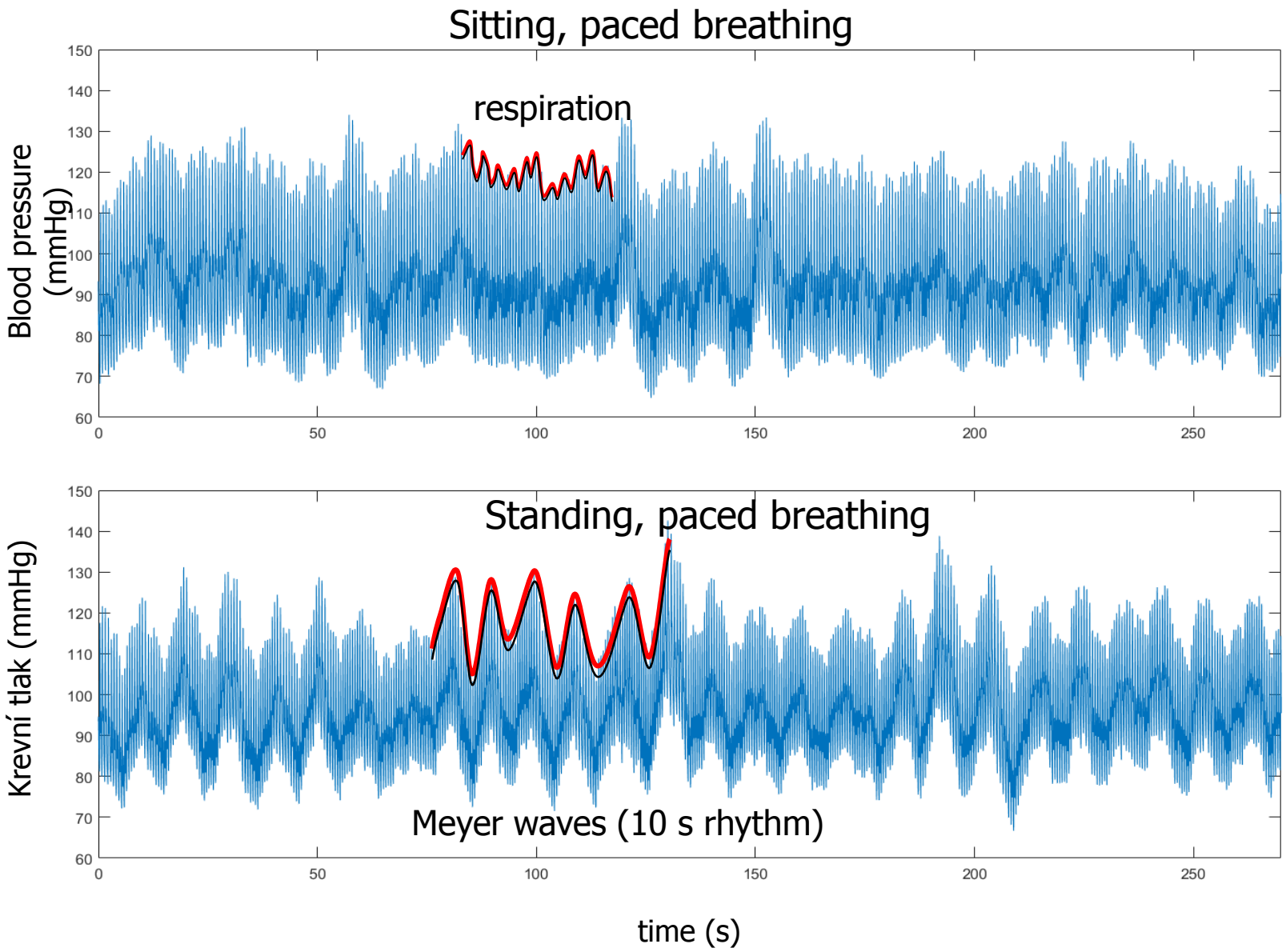
Physiological significance – frequency bands




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

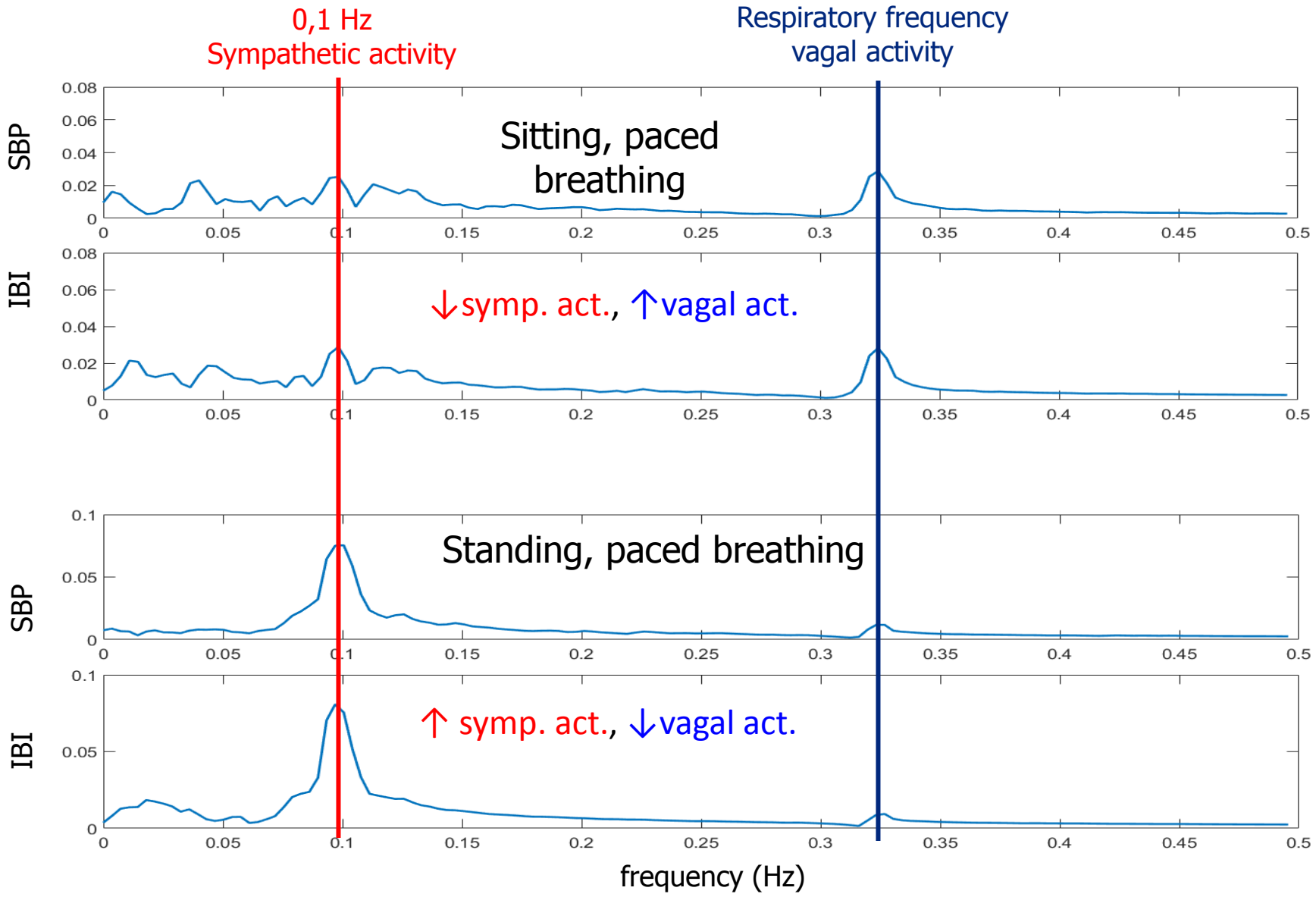

parasympathetic activity
Sympathetic activity
Time lag < 1 s
fast oscillations
Time lag > 6 s
Slow oscillations
CNS (n. vagus)
Heart rate
Spectrum HR (n.u.)
0,2
0,0
0
baroreflex
Mechanical transfer
???
0,12
Changes of TPR (sympathetic nerves)
Thoracic pressure changes
Systolic blood pressure
Spectrum SBP (n.u.)
0,08
0,04
0
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)



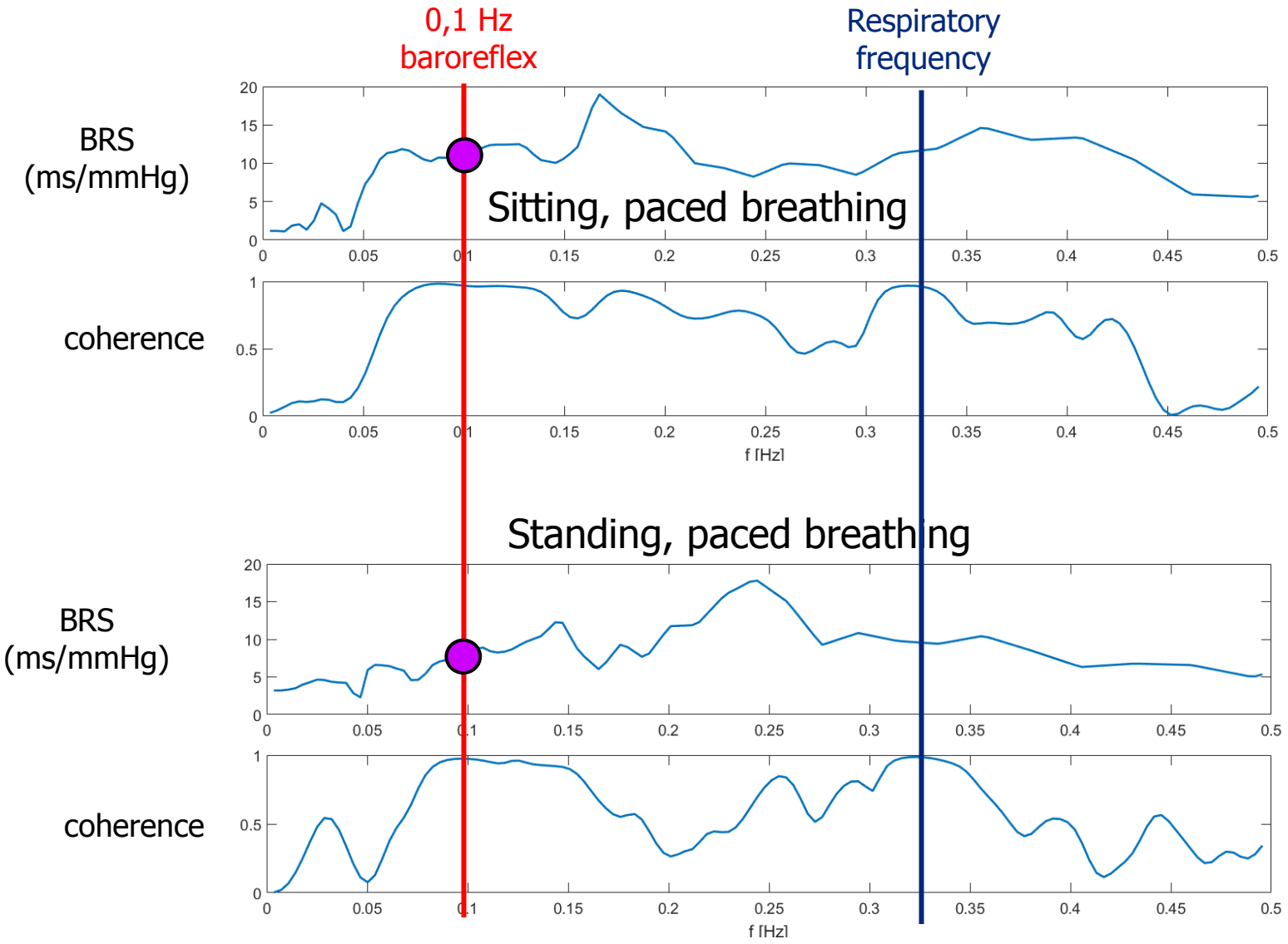
sequentions of SBP, DBP and inter-beat intervals

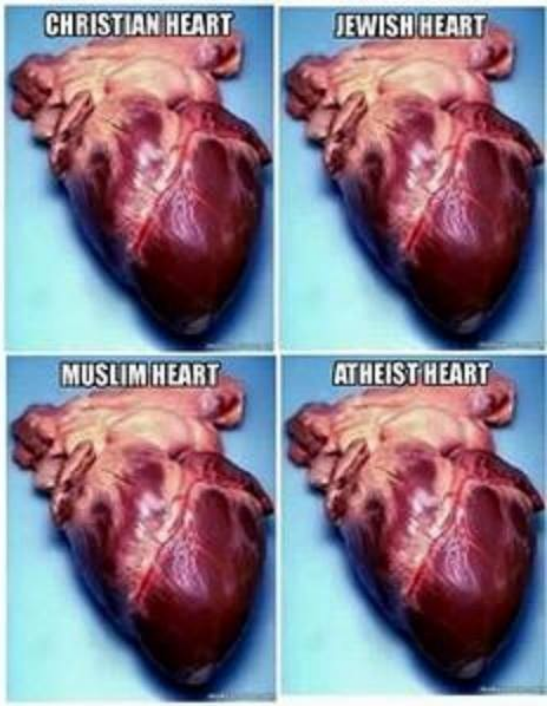
Spectra of SBP and IBI



Coherence a BRS

coherence: synchronization between signals (correlation on particular frequency)





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