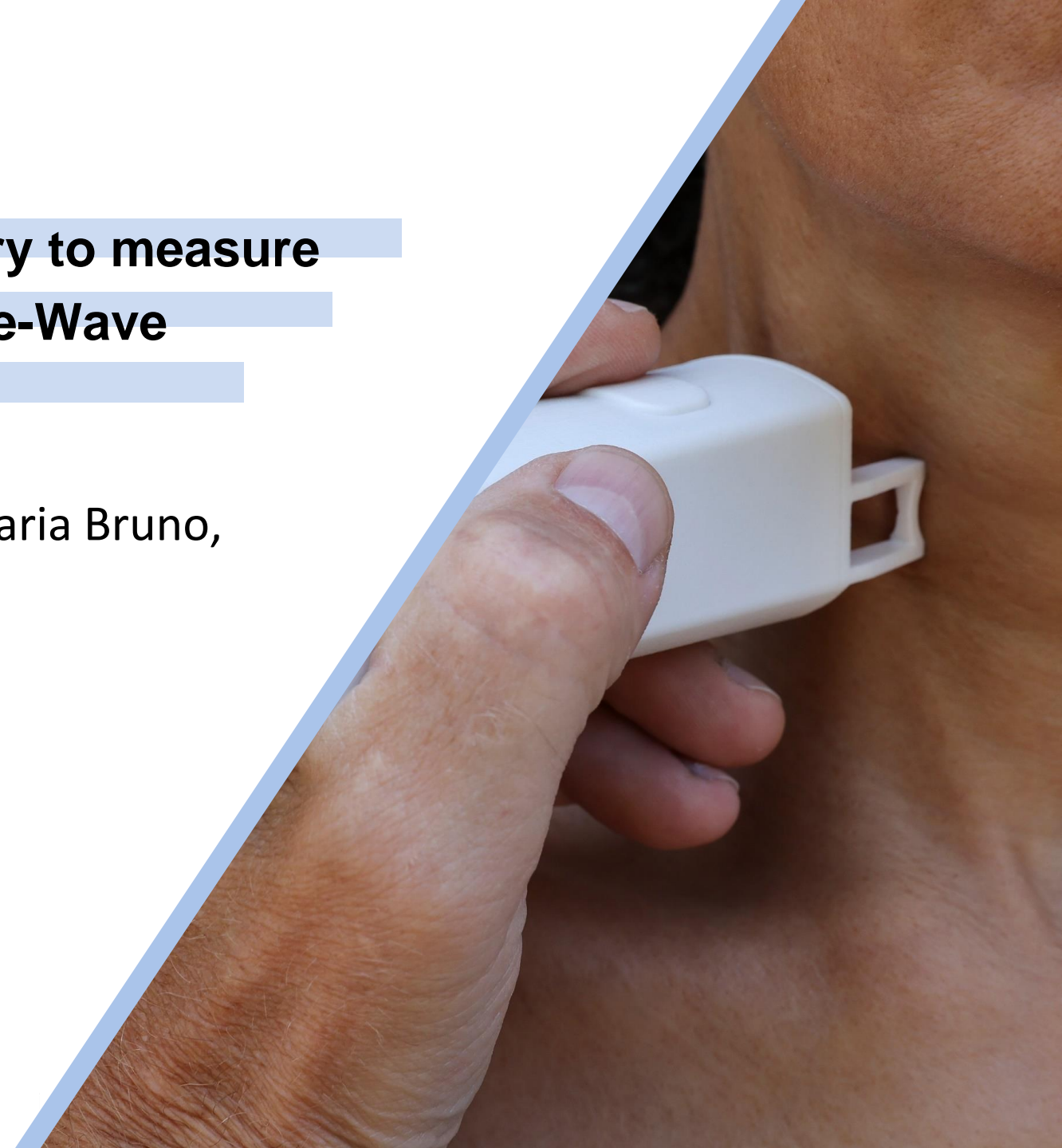


# Feasibility of Laser-Doppler-Vibrometry to measure cardiac signals for Heart-Carotid Pulse-Wave Velocity estimation

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On behalf of the InSiDe partners

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# Project rationale

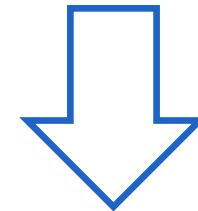
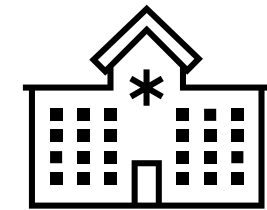
Cardiovascular disease = biggest killer in the world

Effective screening methods needed

- Expensive
- Require expertise
- Dedicated healthcare institutions e.g. hospitals

Alternative to e.g. ultrasound & tonometry → CARDIS device

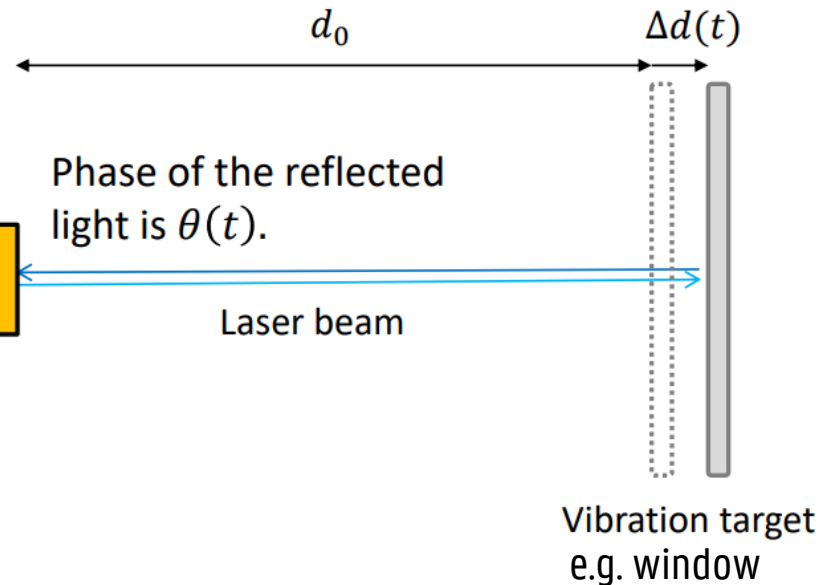
- User friendly option targeted at GP level
- Quick & comfortable measurements



# Laser Doppler Vibrometry

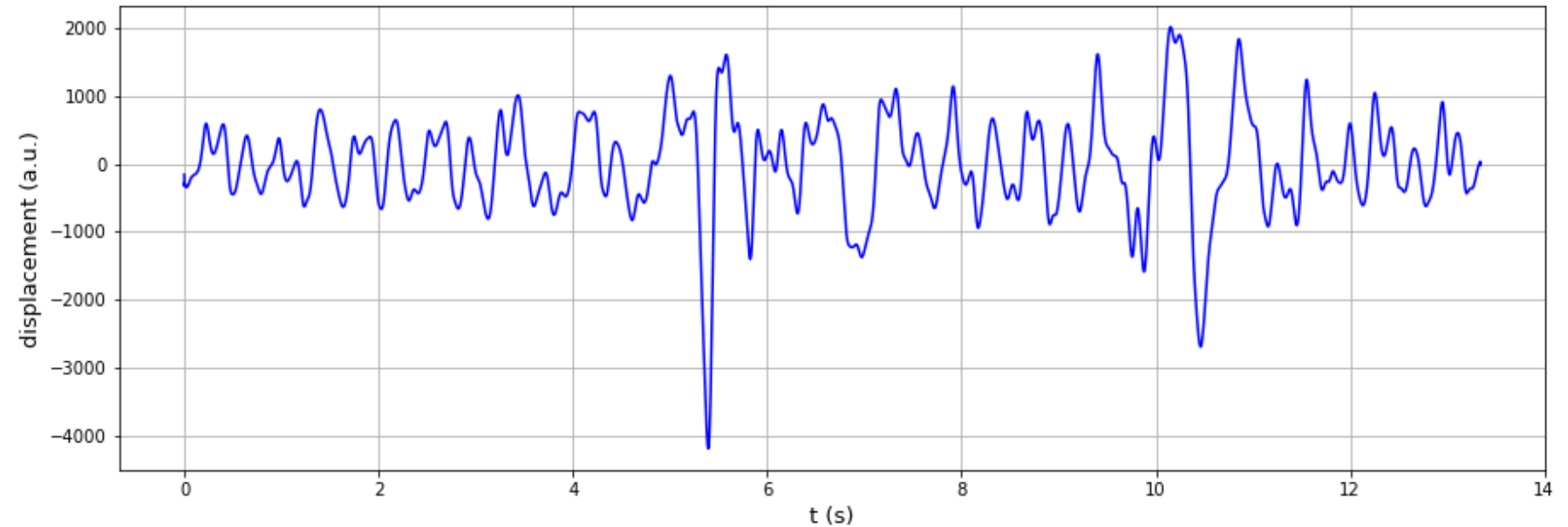
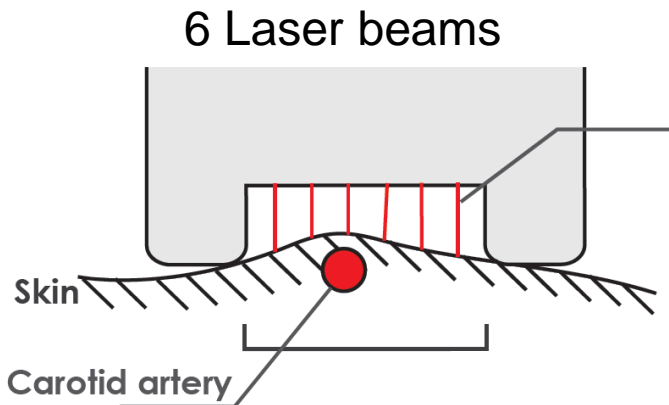
From soviet-era espionage to...

- Seismology
- Landmine detection
- Aerospace
- Healthcare
- ...



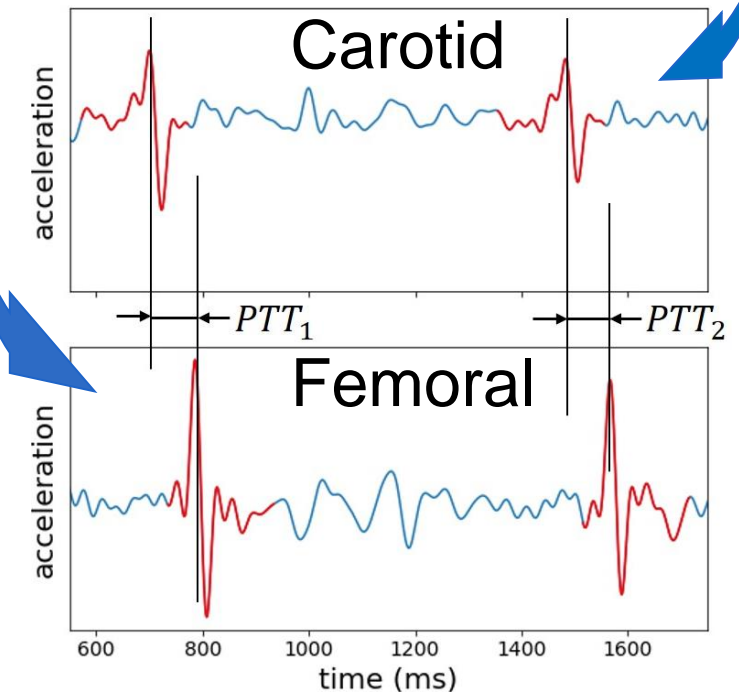
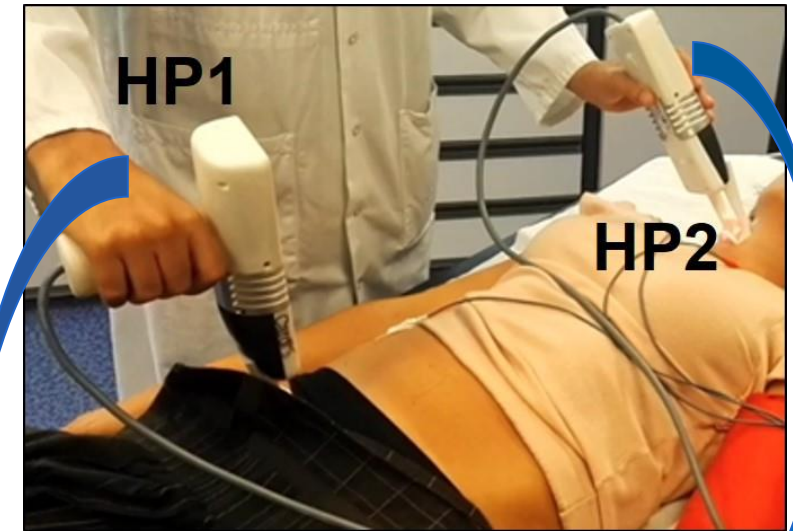
# Laser Doppler Vibrometry

Measuring skin vibrations (with patch)



# Biomarker

- Pulse-wave velocity (PWV) as biomarker for arterial stiffness
- Carotid-femoral most used
- CARDIS device
  - Skin displacement ( $\rightarrow$  acceleration)
  - Pulsatile character
  - Linked to pressure wave in arteries
  - Carotid and femoral measured simultaneously



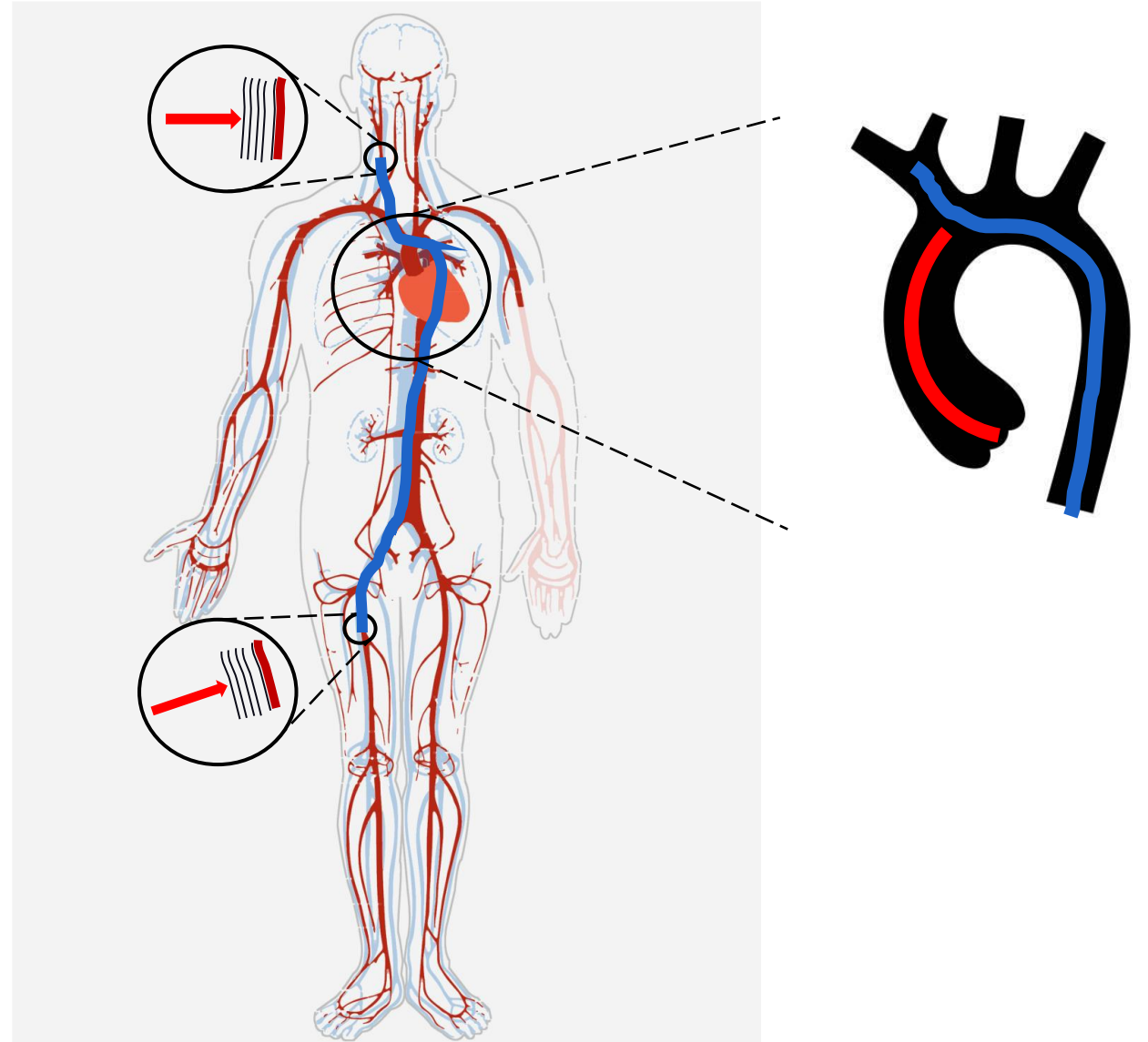
# Biomarker

## Issues with cf-PWV

- Pathway contains more muscular artery regions
- Ascending aorta = critical elastic region not assessed

Potential solution:

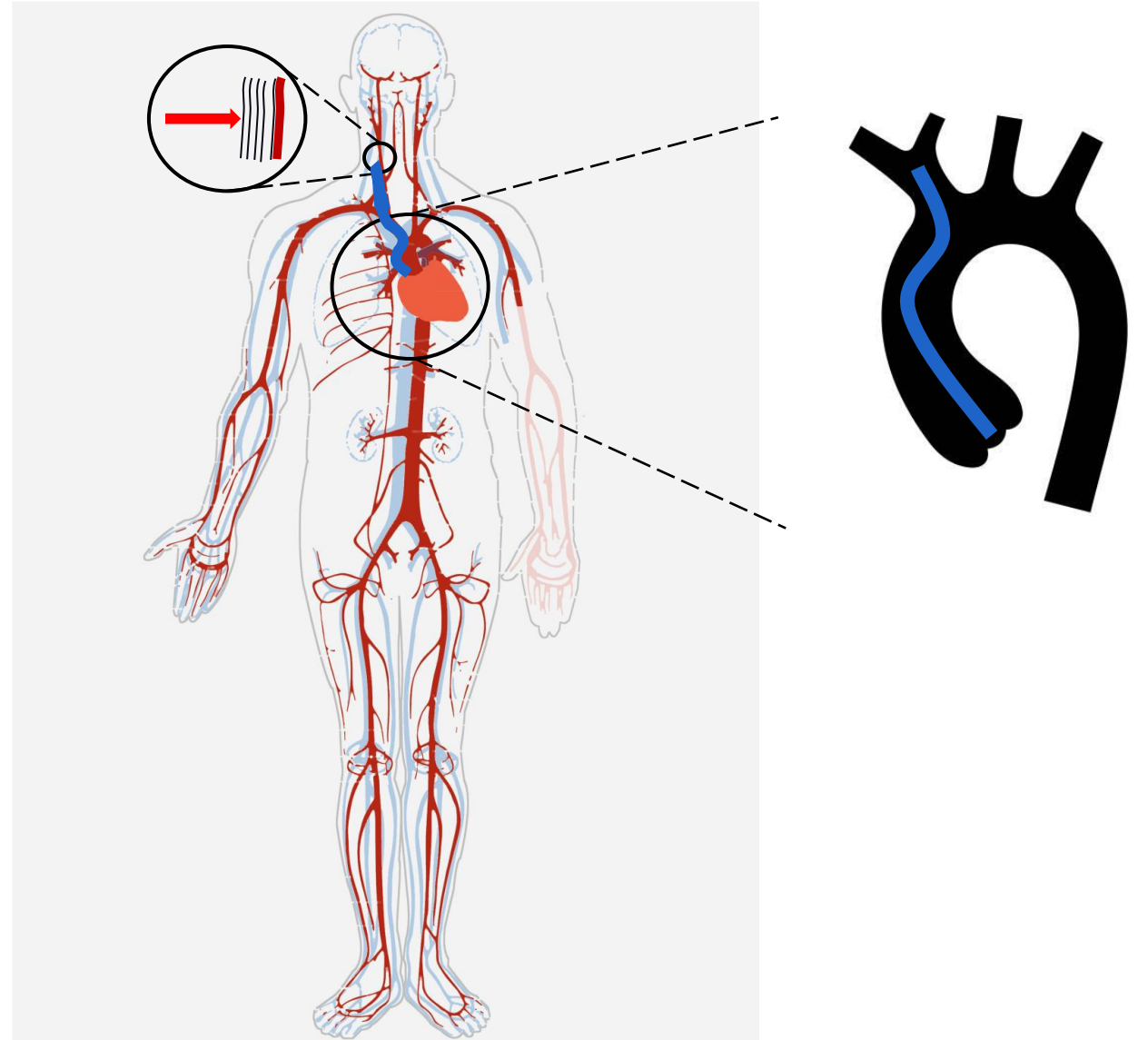
→ Heart-carotid PWV



# Heart-carotid PWV

Elastic regions included, but...

- What measurement site?
- What signal feature? → what cardiac event?



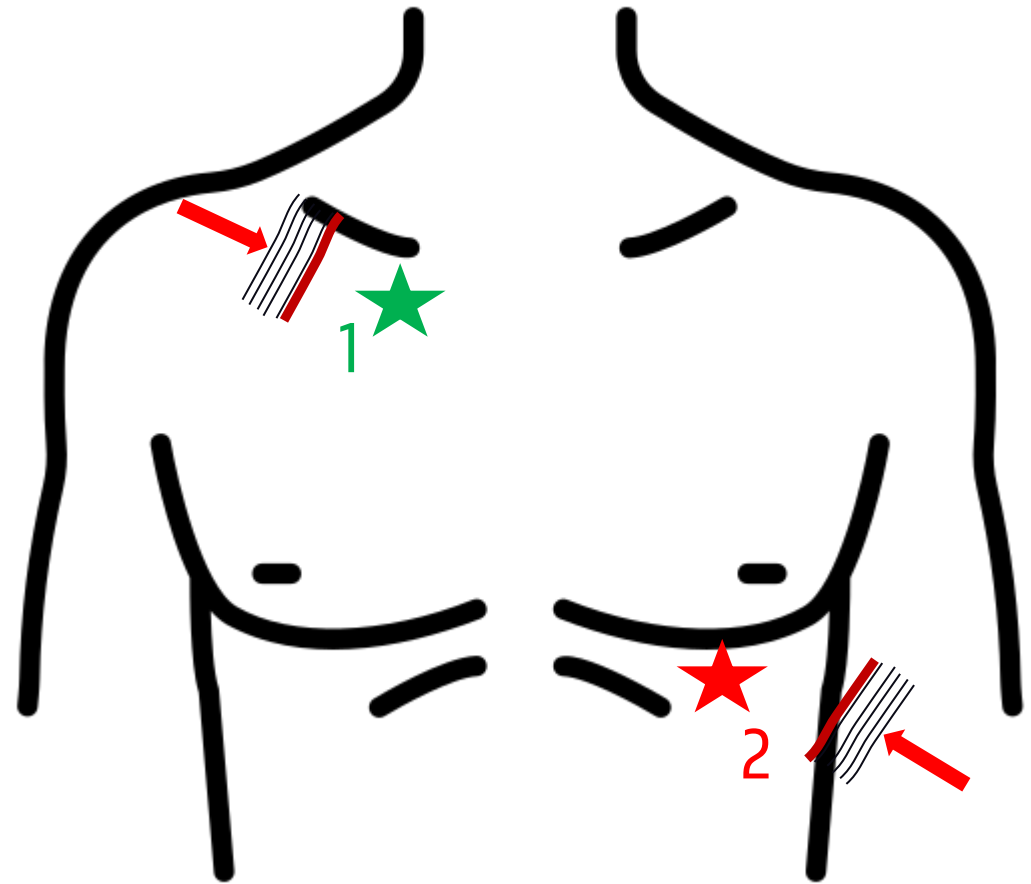
# Heart-carotid Hypothesis

Heart-carotid (hc) PWV

1. Base: Right 2nd intercostal space
2. Apex: Left 5th intercostal space

Measure 100 subjects

- Ongoing in Paris (HEGP)
- Feasibility hc-PWV
- MRI for reference values (see poster Smriti Badhwar)





# Heart-carotid LDV Data

6 x Carotid channels

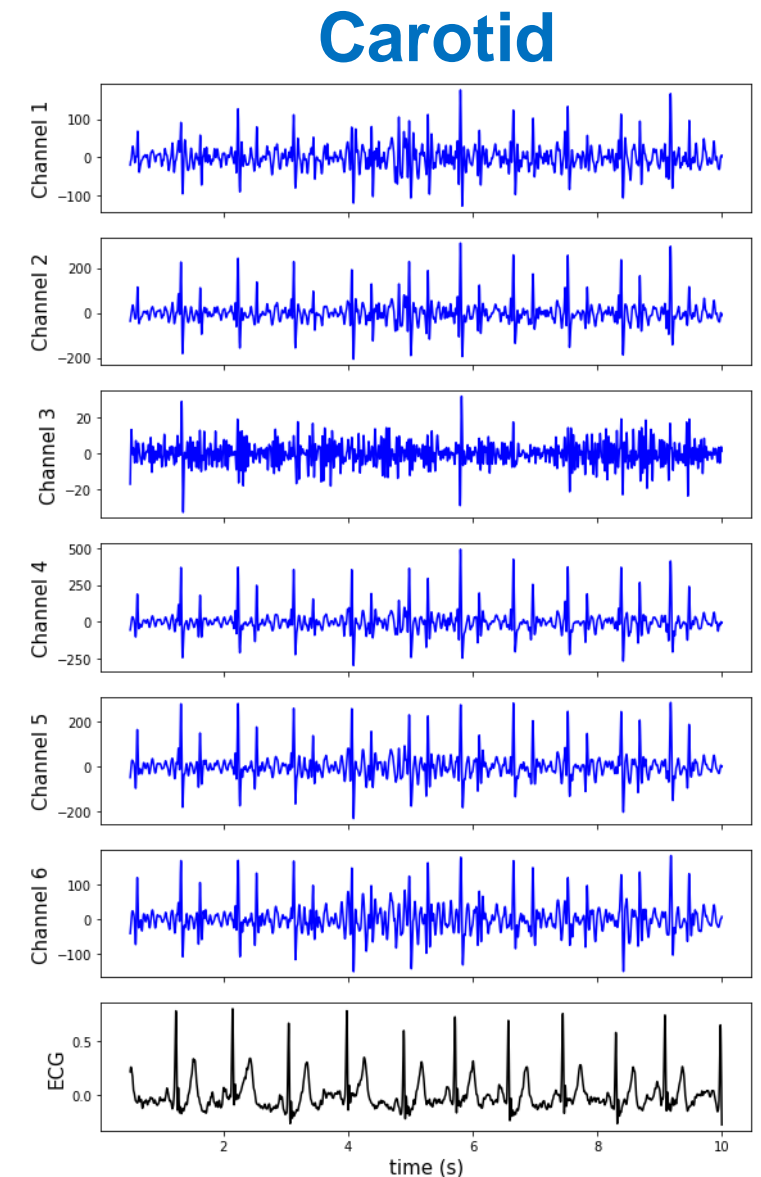
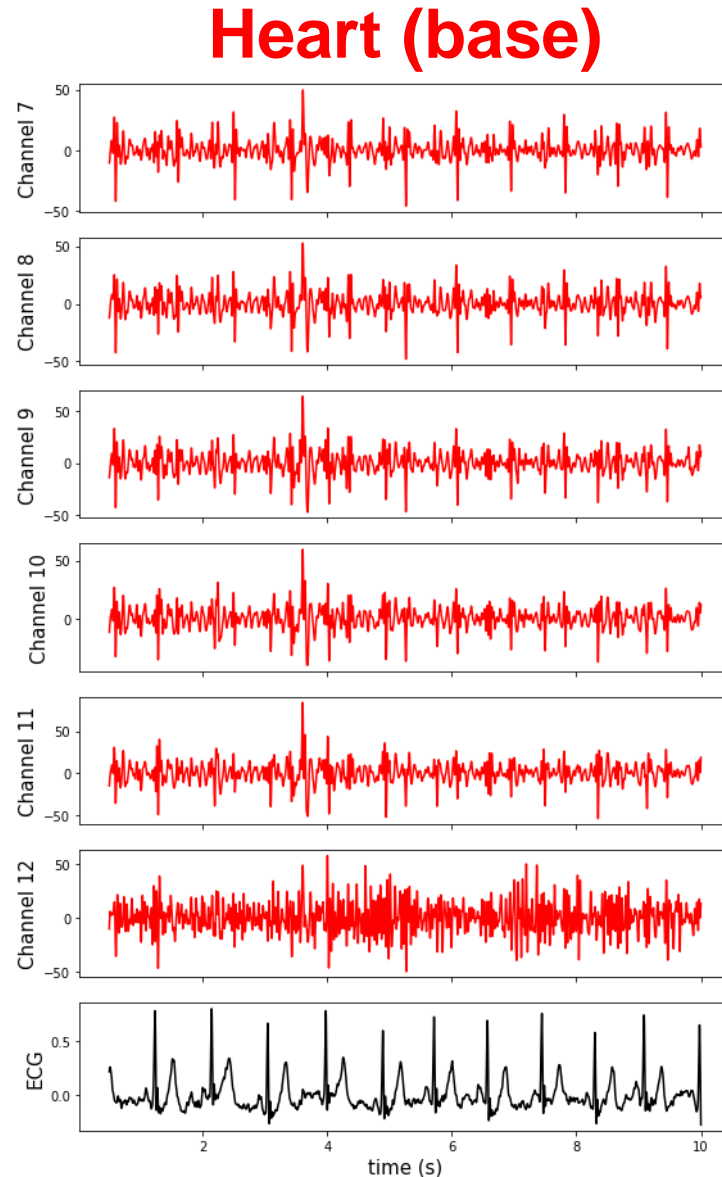
6 x Heart (base) channels

1 x ECG trace

→ Higher chance 1 or more

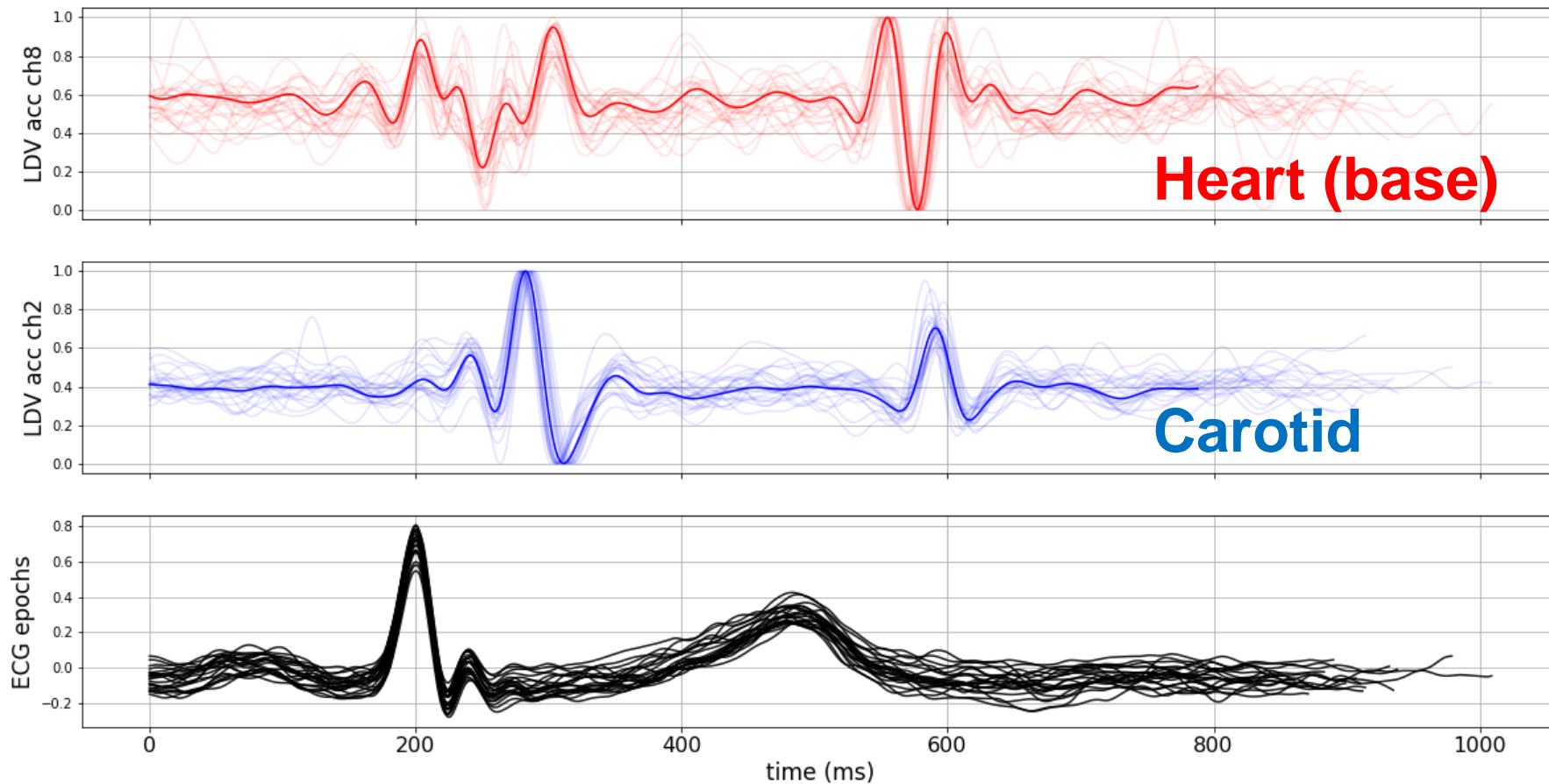
'qualitative' channels

→ Acceleration for feature detection (similar to cf-PWV)



# Heart-carotid Data

- Using ECG: split into epochs  $\rightarrow$  epoch average
- heartsound 1 & 2 detectable?

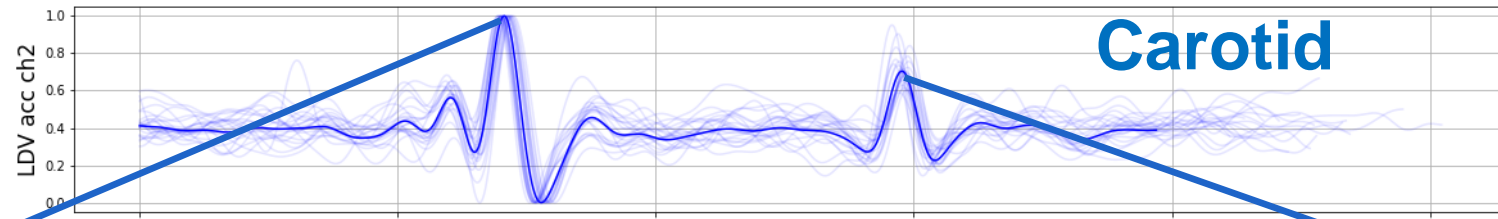
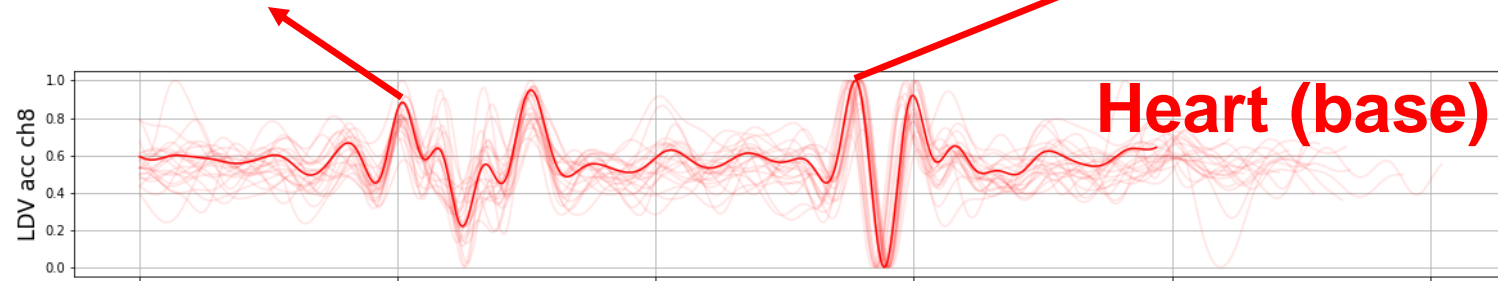


# Heart-carotid signal features

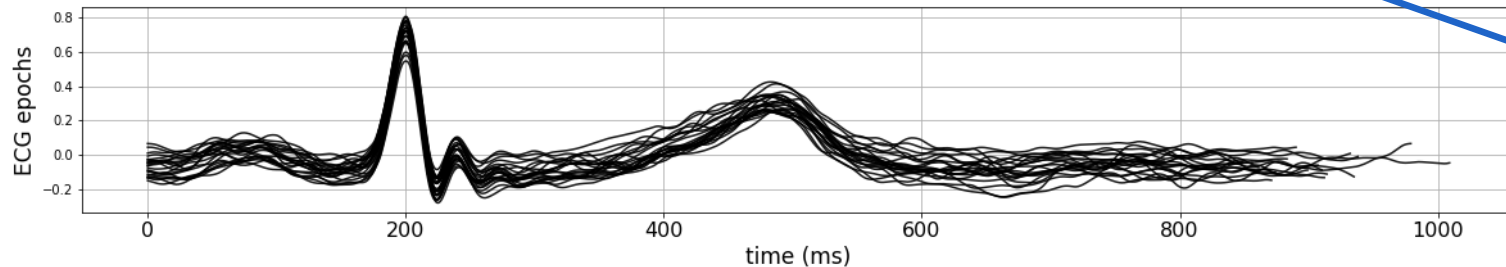
Heartsound 1 → closure Mitral valve



Heartsound 2 → closure aortic valve



Foot-of-the-wave waveform (opening aortic valve)



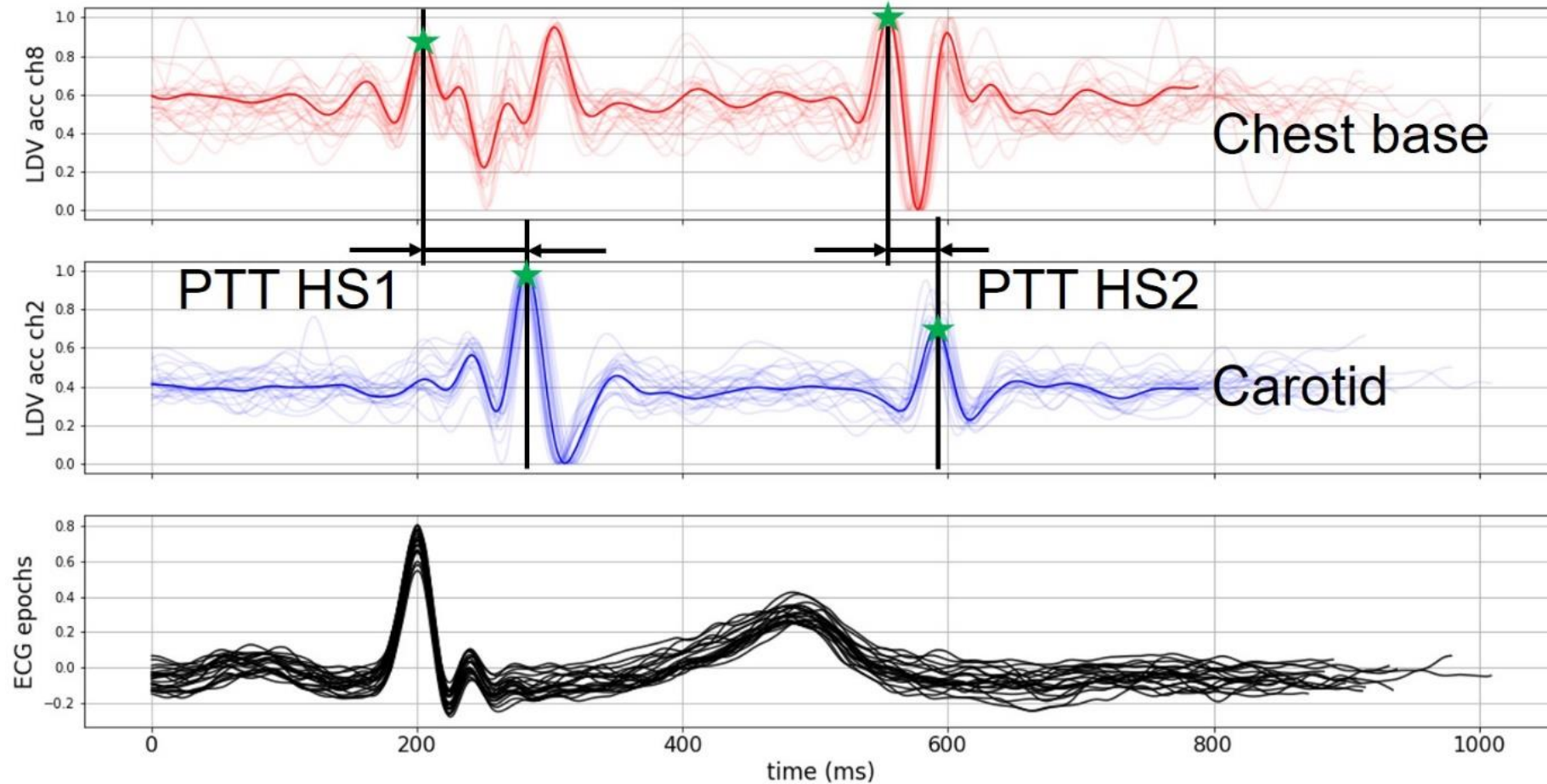
Dicrotic Notch (closure aortic valve)



# Heart-carotid PTT estimation

Pulse transit-times (PTT) via both heartsounds

→ HS1 – FOW matching contains isovolemic contraction period



# Conclusion & future prospects

- Expand database & analysis
- Updated prototype
  - No patch!
  - 4 beams per HP
  - Lighter - wireless



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[www.ugent.be/ea/ibitech/en/research/biommeda](http://www.ugent.be/ea/ibitech/en/research/biommeda)

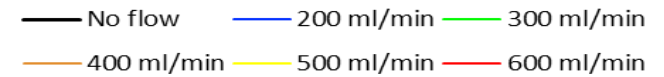
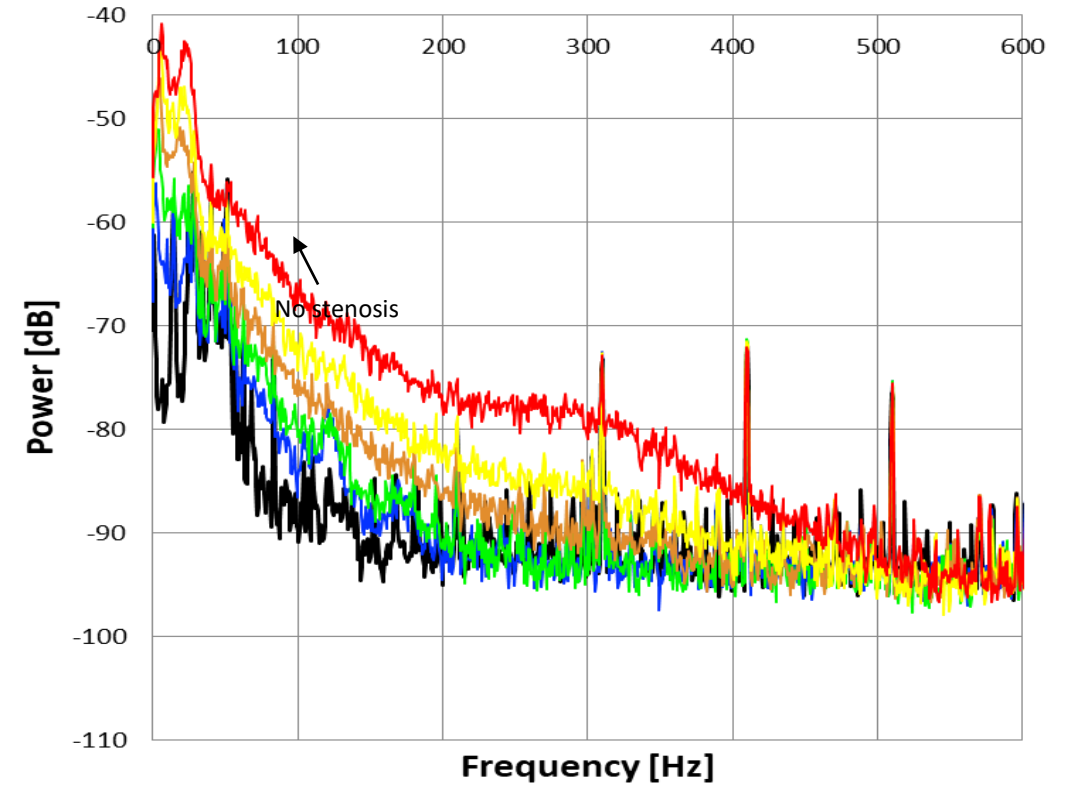
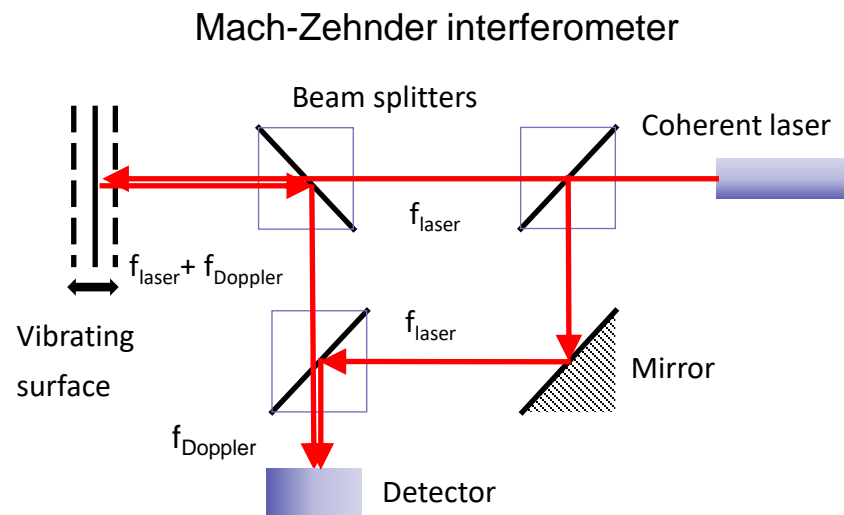
[www.inside-h2020.eu](http://www.inside-h2020.eu)



**H2020 grant agreement**  
**Nr. 871547**



# Backup



# Backup

- Device consists of 2 handpieces
- Each handpiece: 6 beams
- Displacement sampled at 10kHz

