Non Invasive real time assessment of Intra-Cardiac Pressures

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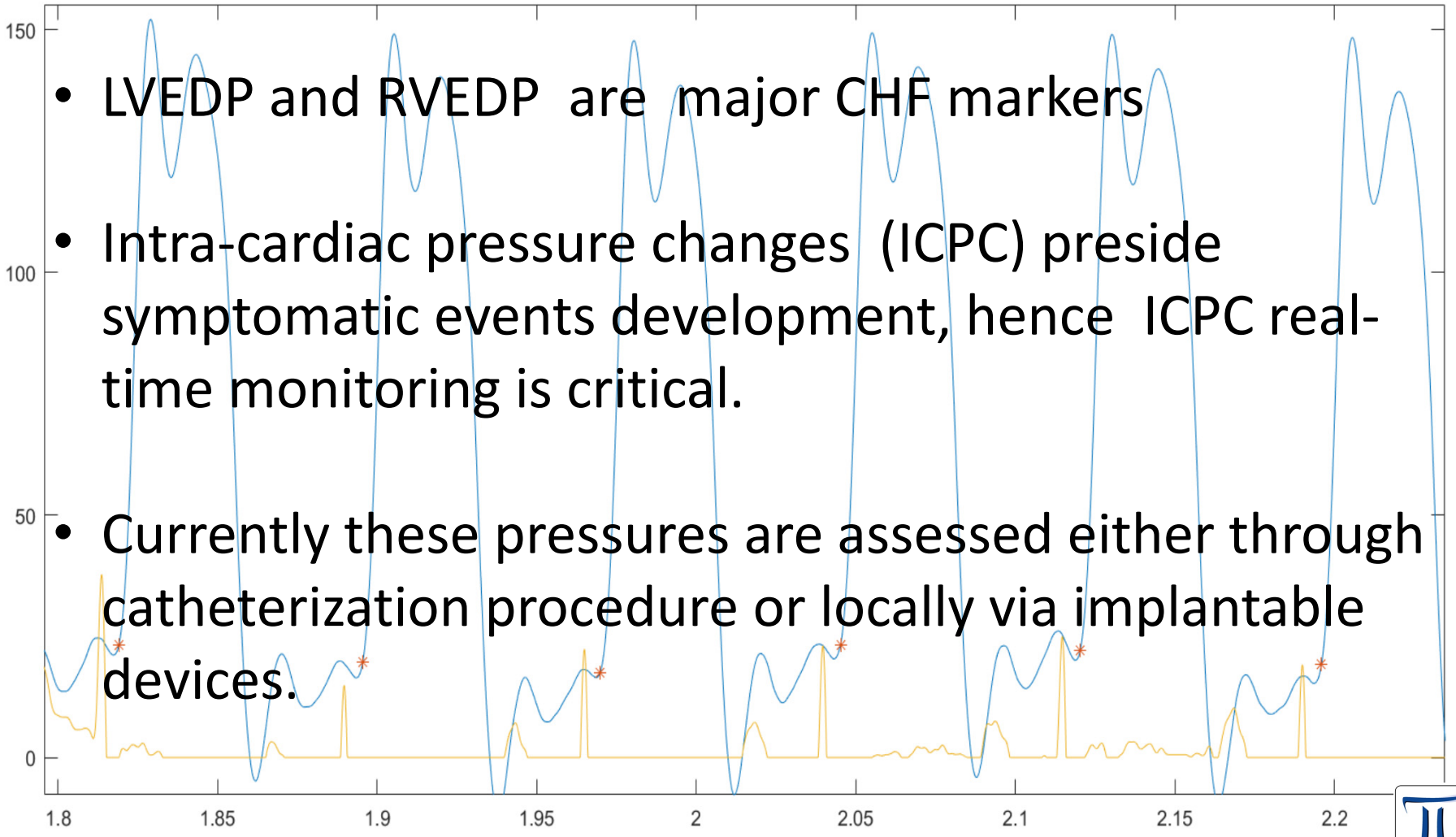
CSI EDUCATION

DISCLOSURE STATEMENT OF FINANCIAL INTEREST

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below

AFFILIATION/FINANCIAL RELATIONSHIP	COMPANY
• Ownership/Founder • Intellectual Property Rights	• Pi-Harvest Holding AG • Pi-Harvest Israel

BACKGROUND

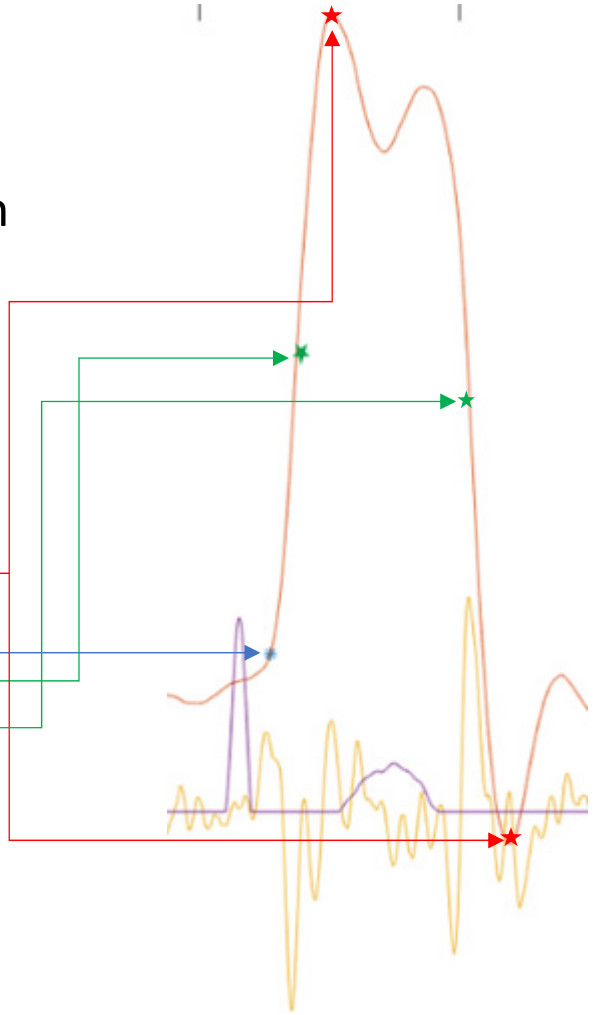


- LVEDP and RVEDP are major CHF markers
- Intra-cardiac pressure changes (ICPC) preside symptomatic events development, hence ICPC real-time monitoring is critical.
- Currently these pressures are assessed either through catheterization procedure or locally via implantable devices.

OBJECTIVES

Real-time system providing

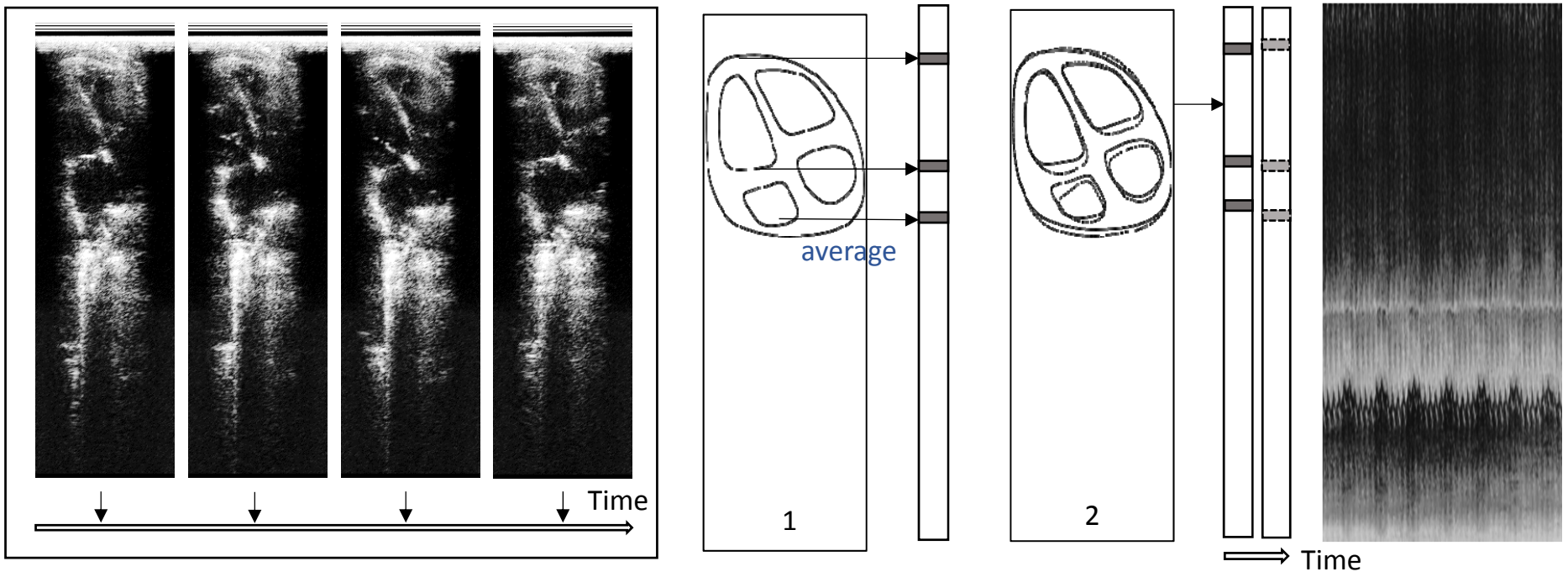
- non-invasive measurement, calculation and prediction of pressures
  - in pulmonary artery and cardiac chambers,
  - assessing left and right ventricular
    - end diastolic pressures (LVEDP and RVEDP),
    - systolic/end systolic (LV/E/SP and RV/E/SP),
  - Left/Right ventricular pressure
    - rise $dP/dt_{max,L/R}$
    - descend $dP/dt_{min,L/R}$
  - and their derivatives forming a self-contained set of markers for CHF
  - describing the major cardiac cycle points connected with
    - ventricular preload, filling, ejection and afterload.



METHODS: Eigen-Image

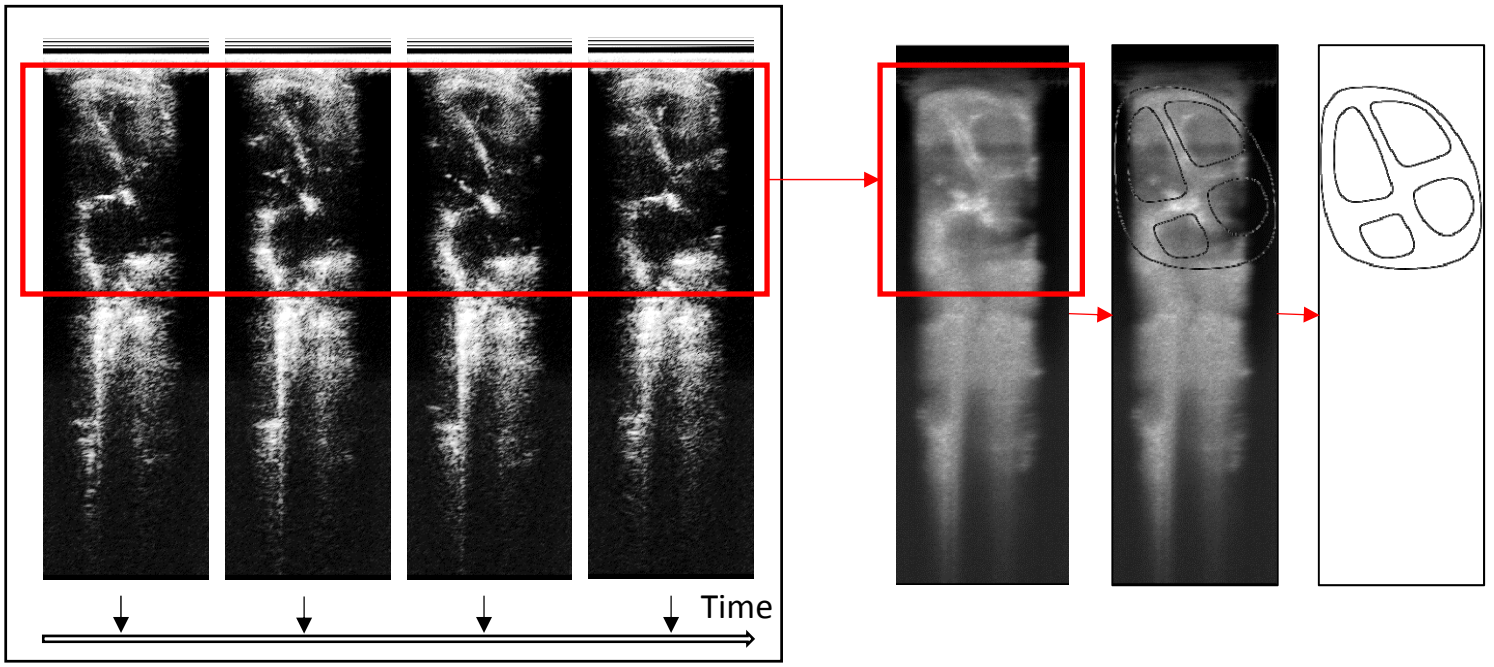
- ***T-image*** $\{T_i\}_{i=1,\dots N}$ is defined as a chronological union of images with corresponding time stamps.

- ***Characteristic (or Eigen-) Image*** $\{I_i\}_{i=1,\dots N}$ of T-image is as a chronological union of it's row averages

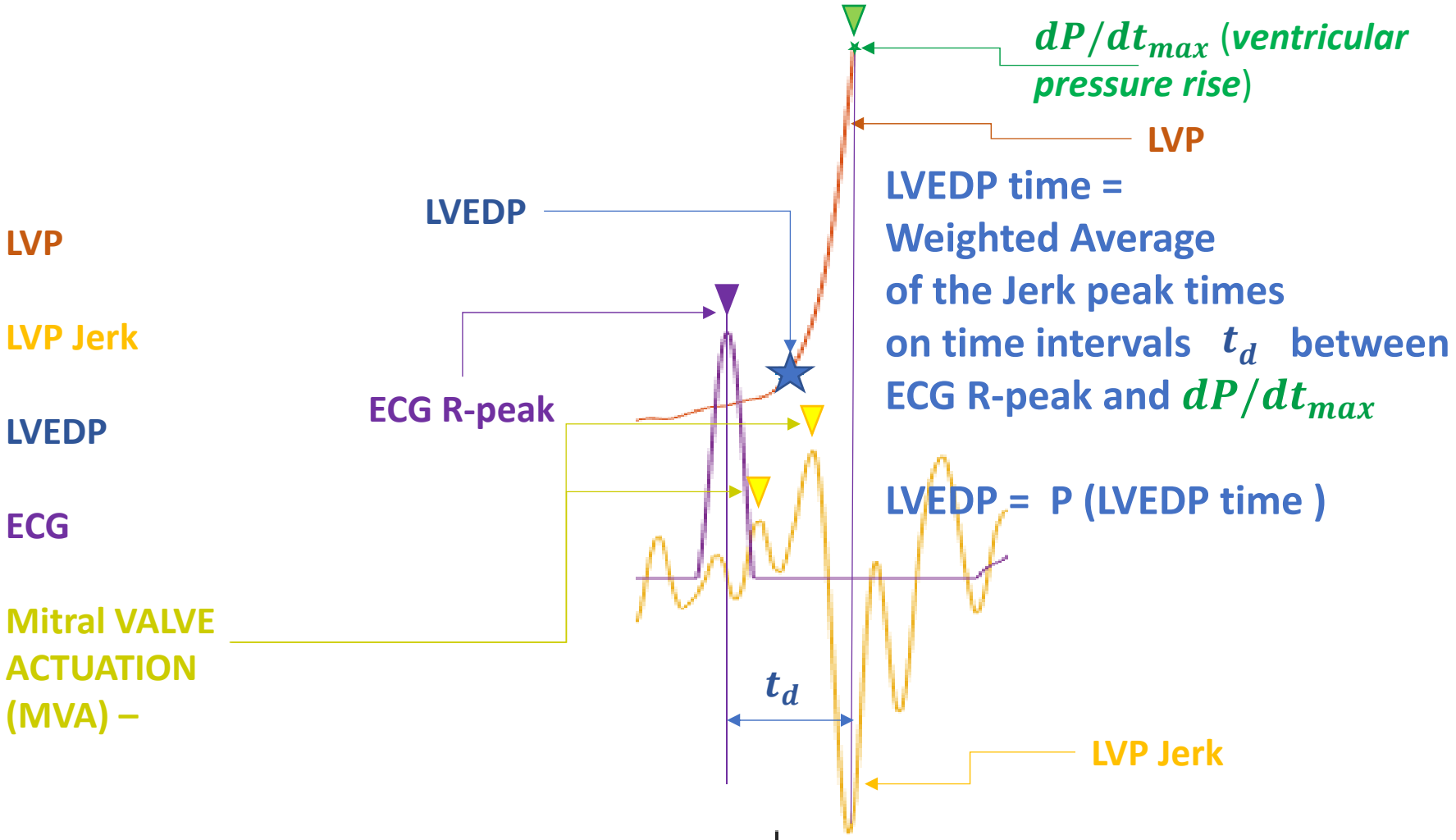


METHODS: T-Image Time Derivatives

- ***T-Image*** $\{T_i\}_{i=1,\dots N}$ ***time derivatives*** $\{T_i\}'_{i=1,\dots N}$, $\{T_i\}''_{i=1,\dots N}$, … are the pixel-wise finite differences of greyscale brightness: $T_i - T_{i-1}$ with subsequent averaging.
- This allows to differentiate the oscillating parts from the environment and determine the heart shape and position.

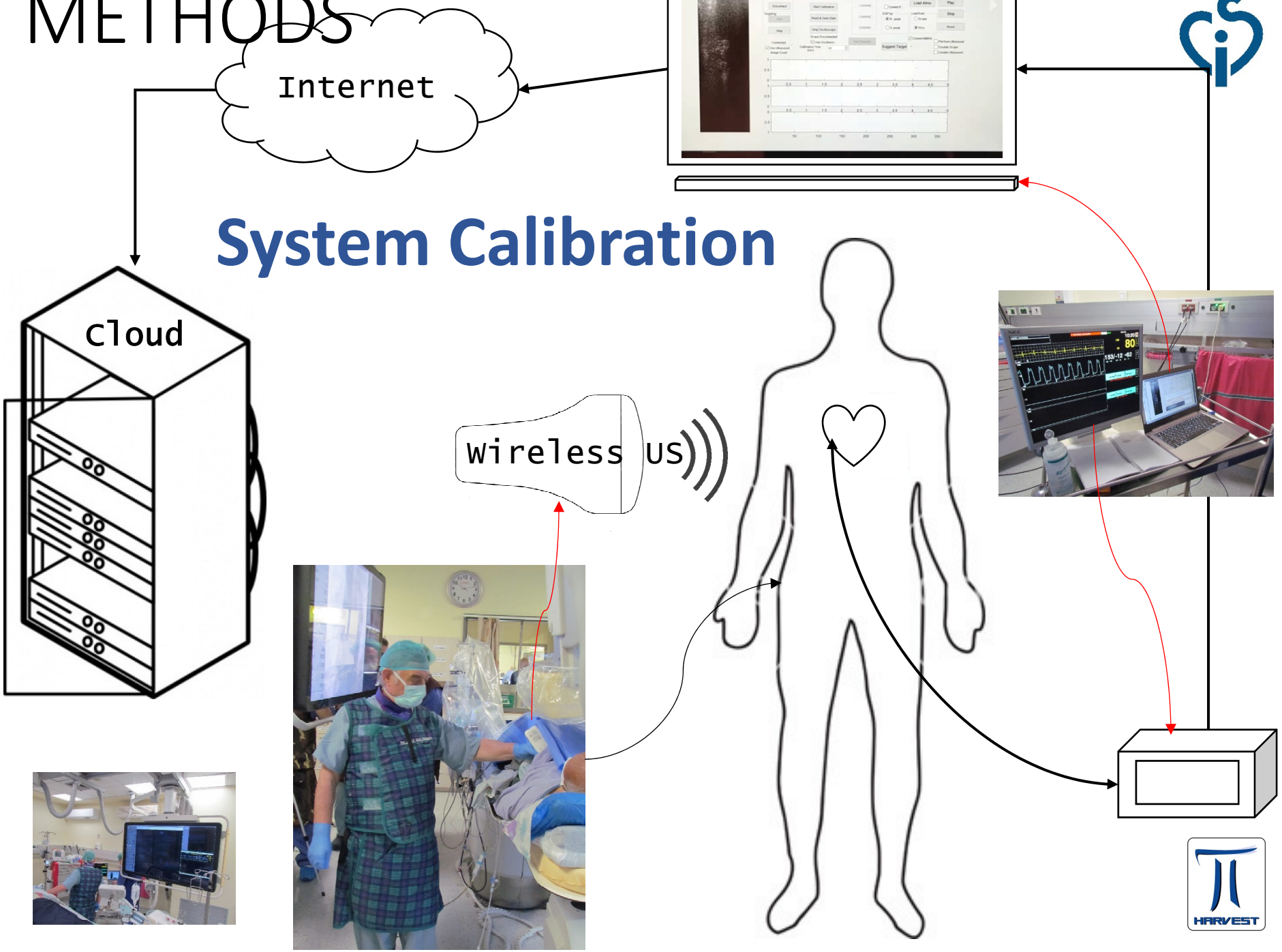


METHODS : LVP Jerk and LVEDP



- If there exists one such LVP jerk peak on this interval, then LVEDP is the pressure at this time moment if there exist more than one such peaks, the LVEDP is the LVP at a time point
- calculated as the weighted average of the two rightmost jerk maxima, where the weights are proportional to the absolute peak ratio of the jerk maxima.

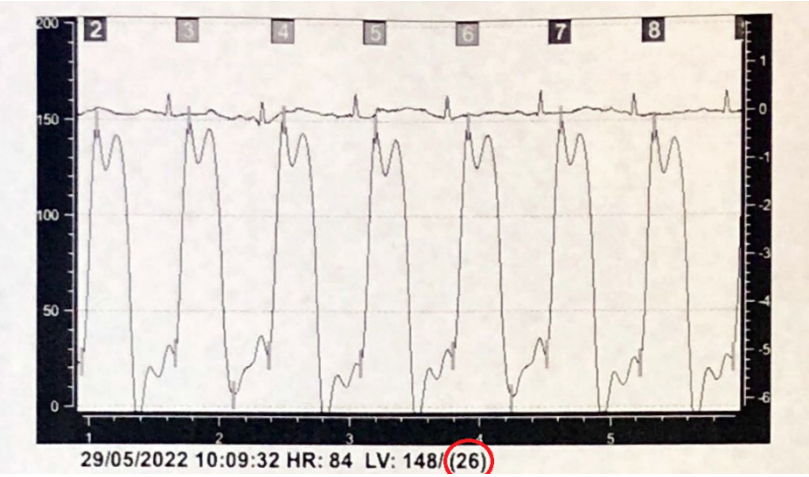
METHODS



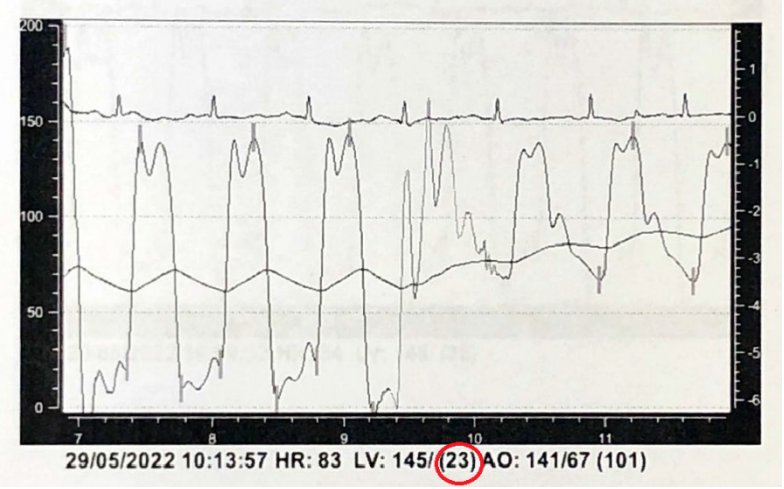
RESULTS: LVEDP measurements and calulations during catheterisaton

Patient with Acute NSTEMI. Hospital pressure monitor:

immediately before stent insertion

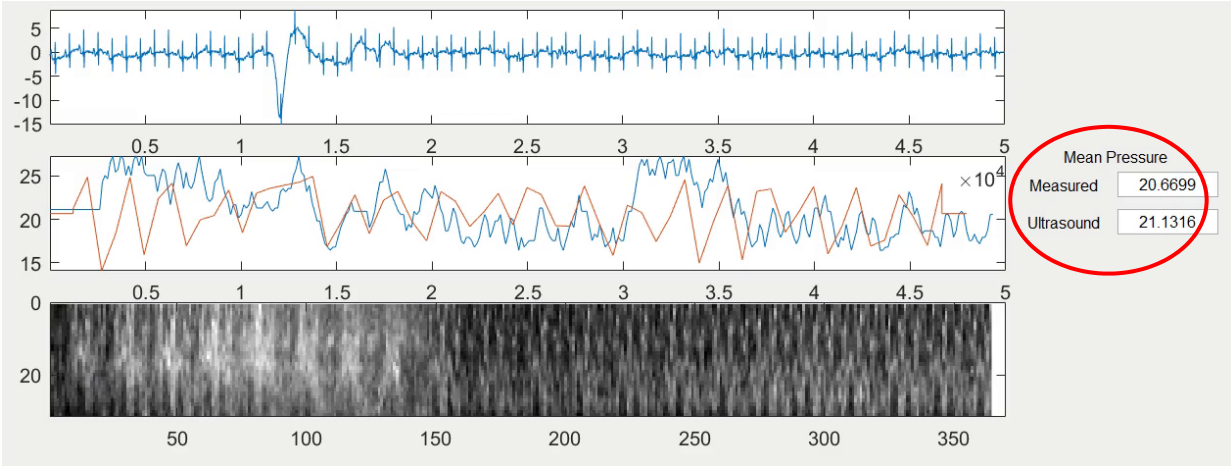


immediately after stent insertion



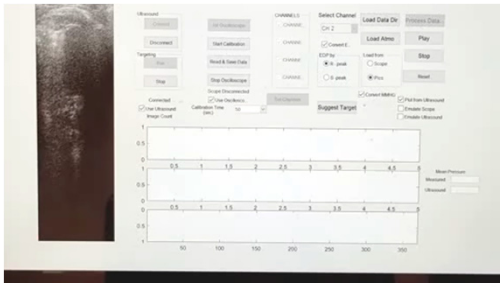
Experiment pressure monitor & calculation at 10:35 (in ~20 min)

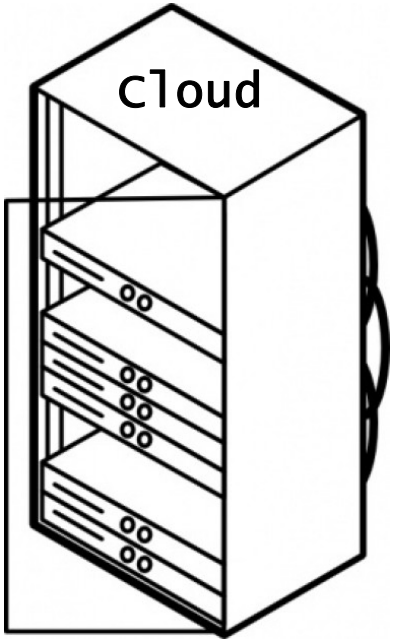
LVEDP 21mmHg

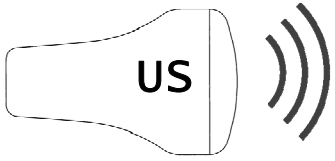


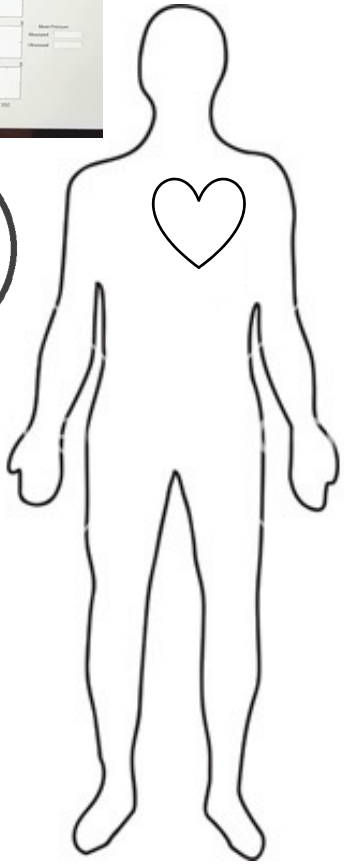
METHODS

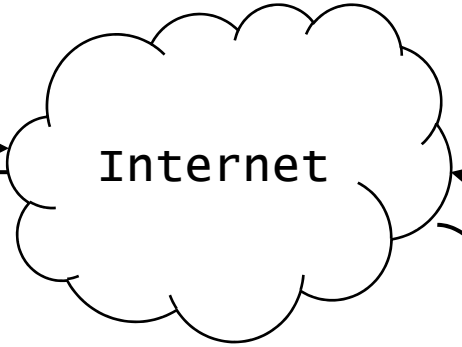
Follow Up











RESULTS L/RVEDP

- The results were confirmed during ongoing human study of 40 patients conducted under the approval of an ethical committee.

- The ultrasound elaborated pressure data functions are of high precision and accuracy comparing to the catheter derived pressures and are valid for most of cardiac dysfunctions

Patient	25		
	Measured RVEDP	Model RVEDP	
Test	Pressure from RVP	Prediction by 1	Prediction by 2
1	12.19	12.20	12.22
2	12.23	12.21	12.23

Patient	8	LVEDP Comparison (mmHg)			
	Measured LVEDP	Calculated LVEDP			
Test	Pressure from LVP	Prediction by 1	Prediction by 2	Prediction by 3	Prediction by 4
1	20.60	20.60	20.72	20.67	20.36
2	21.10	21.08	21.11	21.20	20.77
3	19.09	19.18	19.57	19.08	19.15
4	17.67	17.46	18.18	17.16	17.67