
Fifth International Symposium on Medical Information and Communication Technology (ISMICT)

27th to 30th March 2011, Montreux, Switzerland

In vivo ULTRAsonic Transponder System for Biomedical Applications

ULTRAsponder

FP7 Collaborative Project, STREP

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English Data 2010

National Heart Failure Audit 2010

1.3 Summary of key findings and main recommendations

As of June 2010.

- The prognosis of heart failure remains poor, even for patients aged under 75 years, despite current therapy. There is substantial scientific evidence that more might be done.
- Within the year of admission for heart failure, 32 per cent of patients died
- Mortality is significantly better for those who have access to specialist care i.e. those seen by cardiologists or specialist heart failure services (23 per cent)

Economic impact of remote patient monitoring: an integrated economic model derived from a meta-analysis of randomized controlled trials in heart failure

**Catherine Klersy^{1*†}, Annalisa De Silvestri^{1†}, Gabriella Gabutti², Arturo Raisaro³,
Moreno Curti², François Regoli⁴, and Angelo Auricchio⁴**

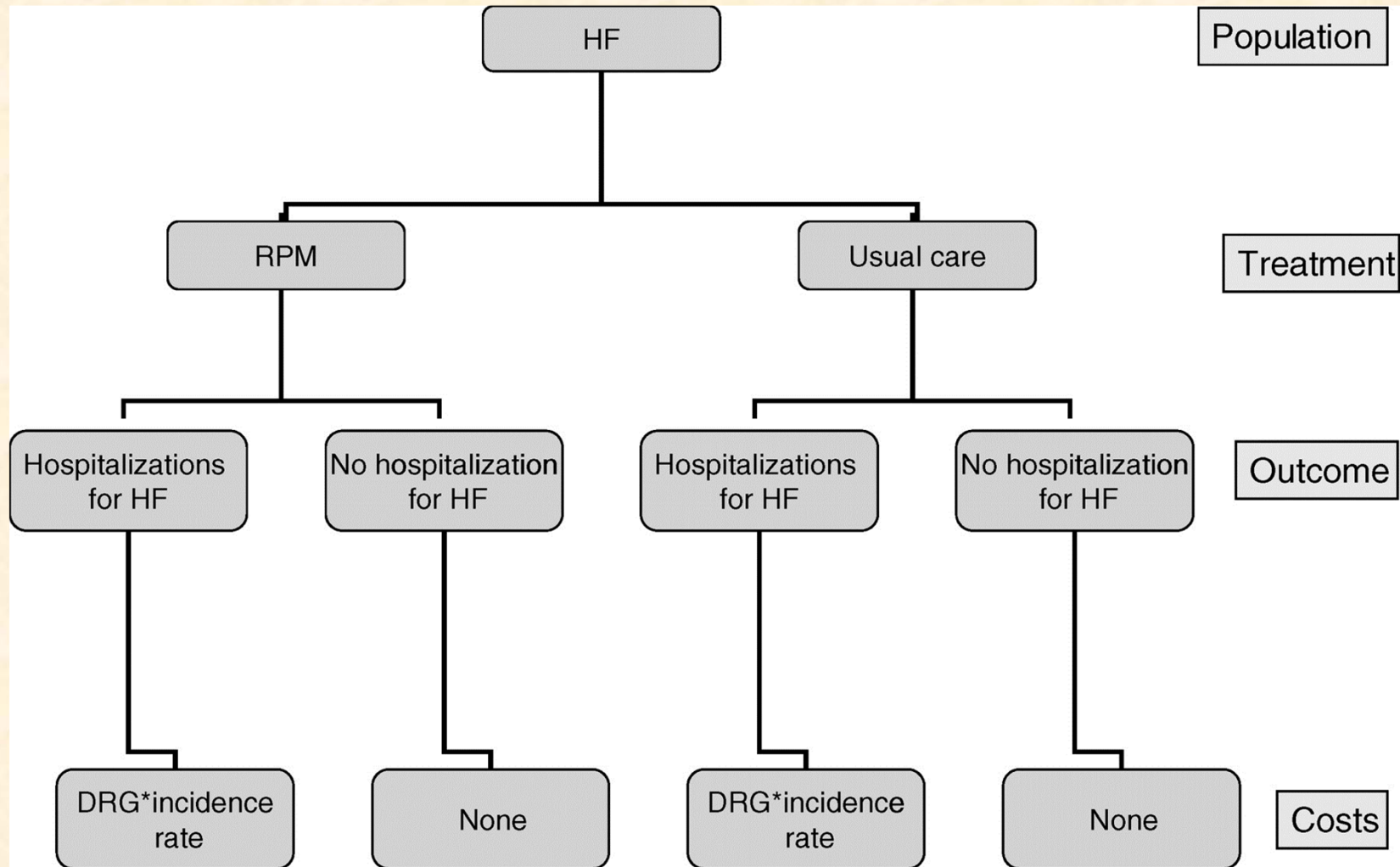
- Remote control of CHF vs Standard Therapy

Improved Quality of Life

Fewer Hospital admissions

Savings of 400-1000 \$/ patient/year

Heart failure and hospitalization costs.



Klersy C et al. Eur J Heart Fail 2011;13:450-459



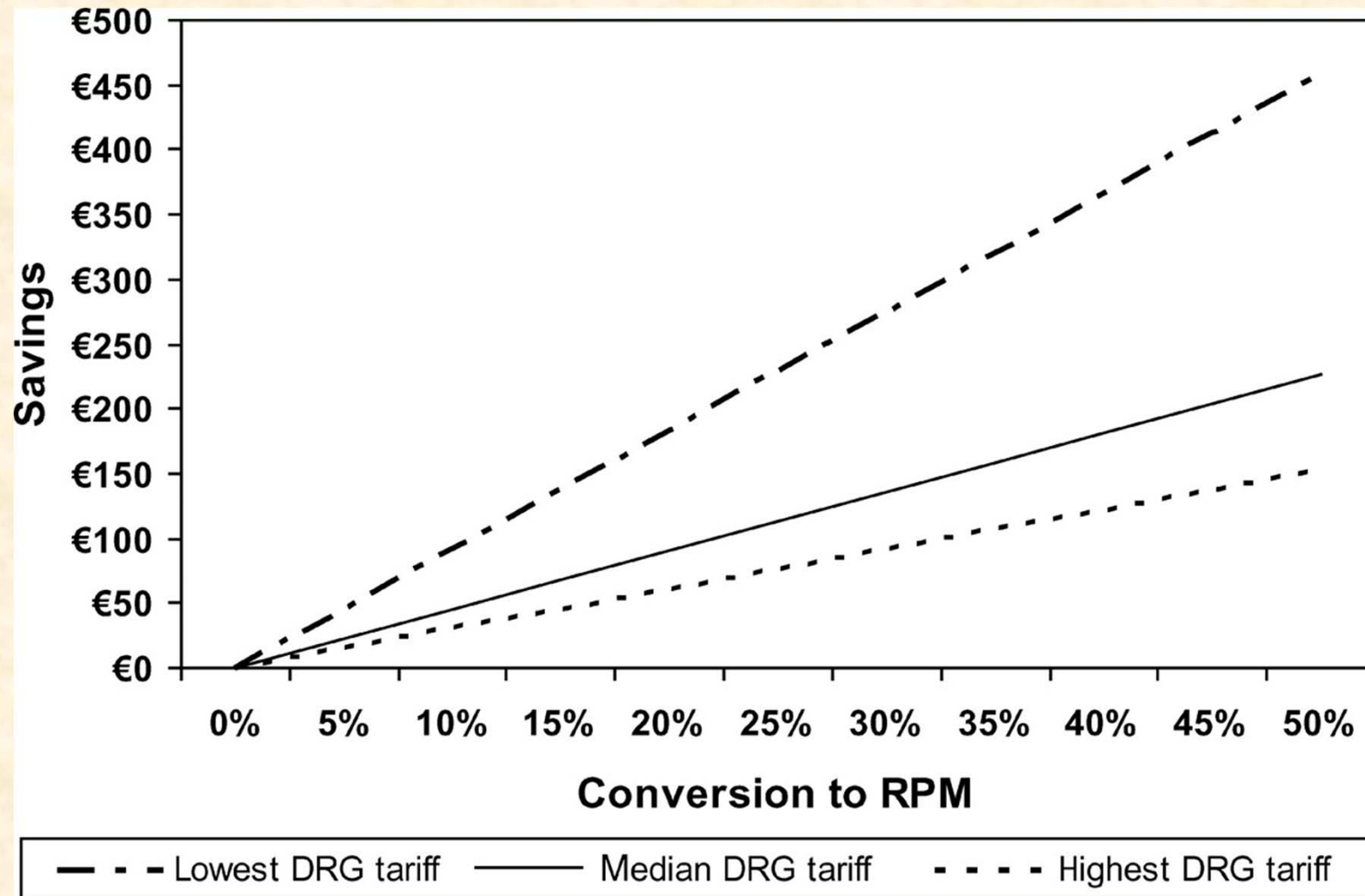
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EUROPEAN JOURNAL OF HEART FAILURE

Budget impact analysis: a simulation study.

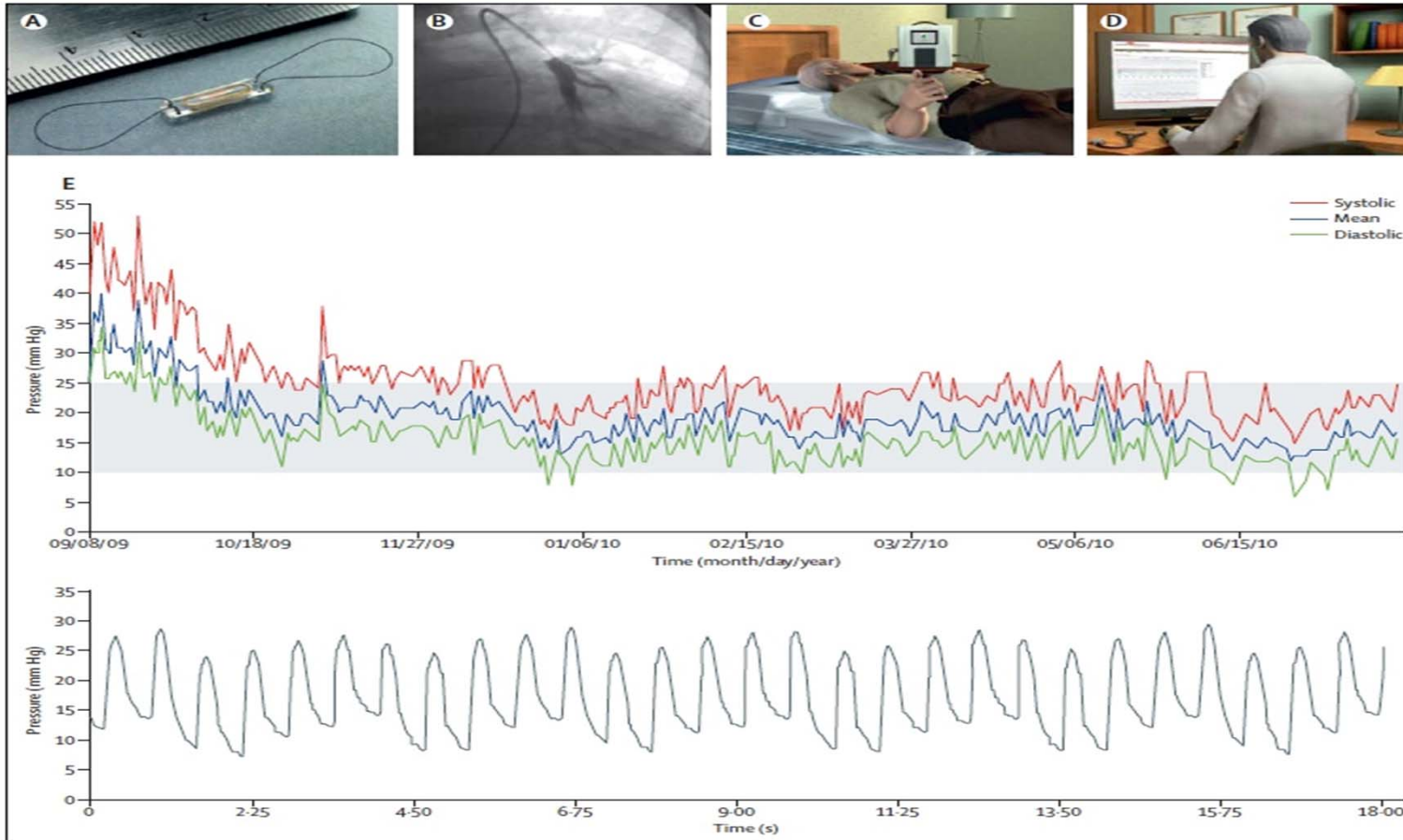


Klersy C et al. Eur J Heart Fail 2011;13:450-459



Wireless pulmonary artery haemodynamic monitoring in chronic heart failure: a randomised controlled trial

William T Abraham, Philip B Adamson, Robert C Bourge, Mark F Aaron, Maria Rosa Costanzo, Lynne W Stevenson, Warren Strickland, Suresh Neelagan, Nirav Raval, Steven Krueger, Stanislav Weiner, David Shavelle, Bradley Jeffries, Jay S Yadav, for the CHAMPION Trial Study Group*

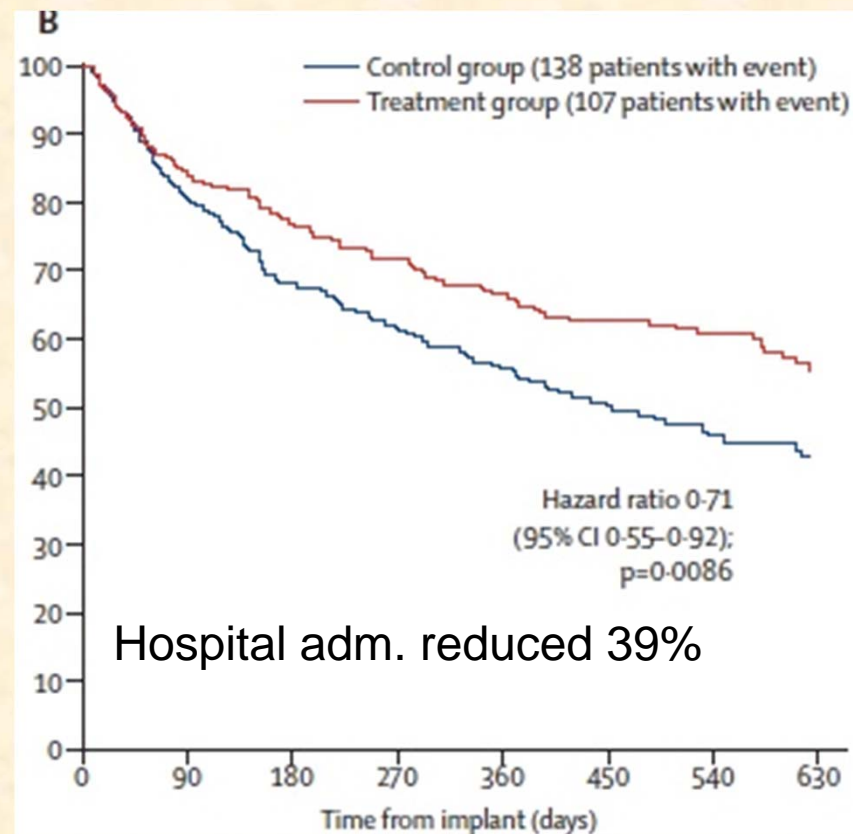
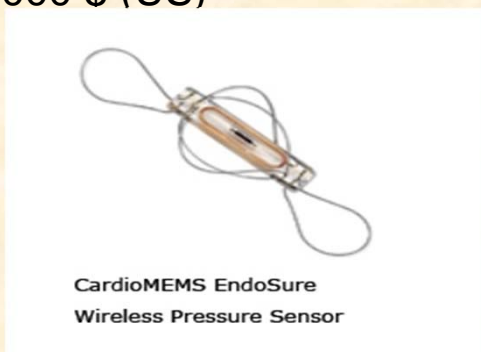




Wireless pulmonary artery haemodynamic monitoring in chronic heart failure: a randomised controlled trial

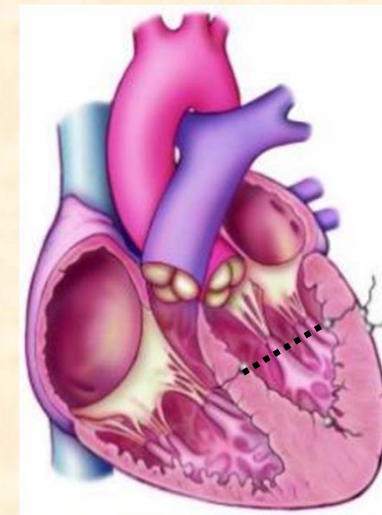
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- Hospital admissions for heart failure (US)
1996: 877 000
2006: 1106 000
- Cost last 2 years of life with heart failure:
156 000 \$ (US)



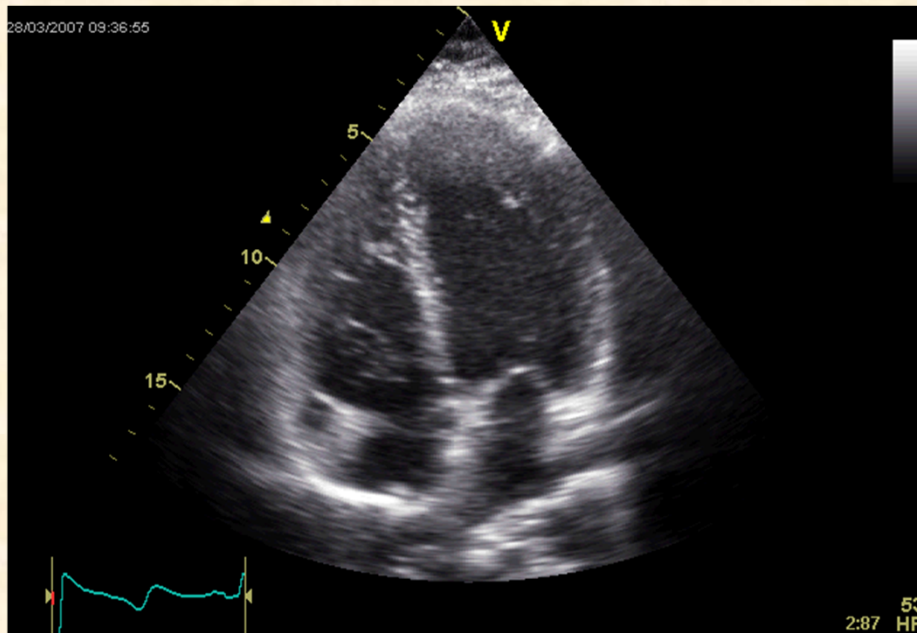
What measurements are of interest in patients with congestive heart failure

- ECG
- Dimension (LV diameter)
- Intracardiac pressures

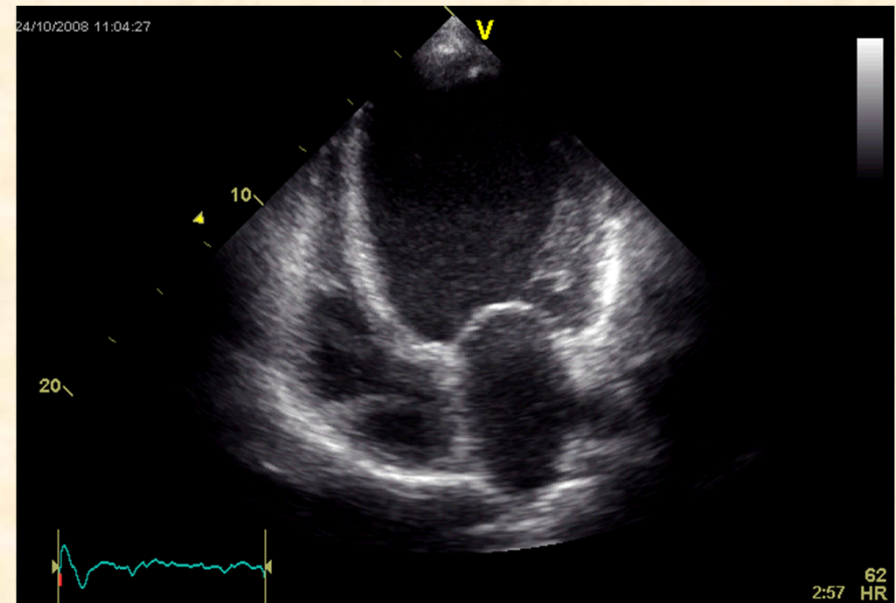


Echocardiography

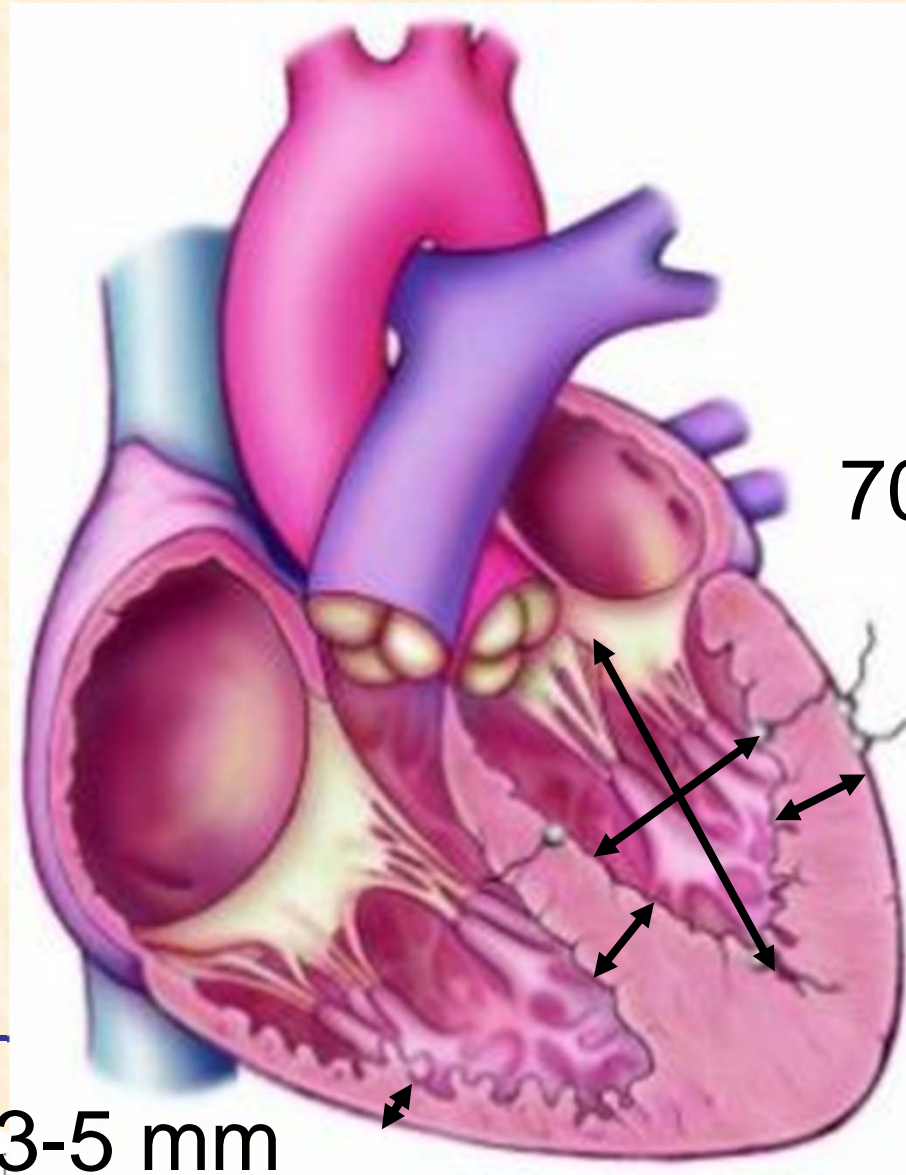
Healthy: Normal size of cardiac chambers



Heart failure: (enlargement of left ventricle and left atrium,



Cardiac dimensions in healthy humans



70-80 mm

50 mm

8-10 mm

3-5 mm

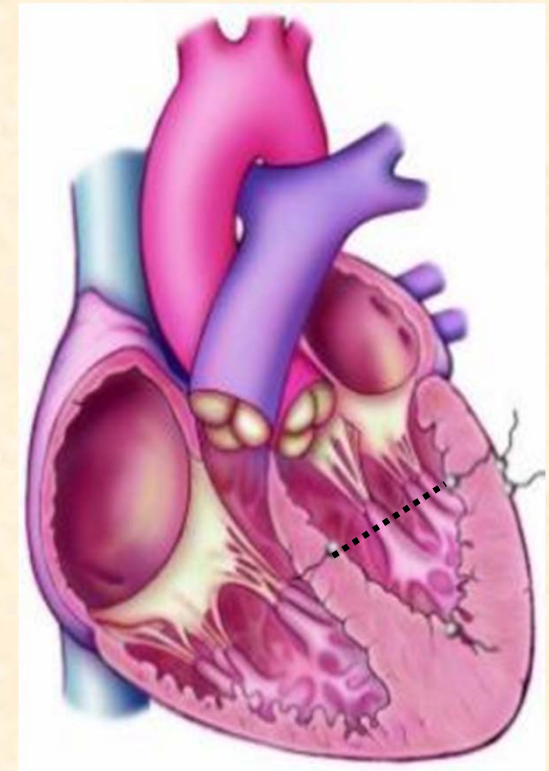
mm

Pressures

- Worsening symptoms in heart failure patients are attributable to increased filling pressures of left atrium and ventricle resulting in pulmonary congestion
- Monitoring cardiac filling pressures may guide fluid management and titration of medical therapy in heart failure

Dimension (LV diameter)

- LV diameter is a sensitive marker of heart failure.
- Increasing LV diameter reflects worsening of heart failure.
- Monitoring of small differences (mm) may help in adjusting medical therapy.
- LV diameter is needed for calculation of cardiac output in addition to heart rate.



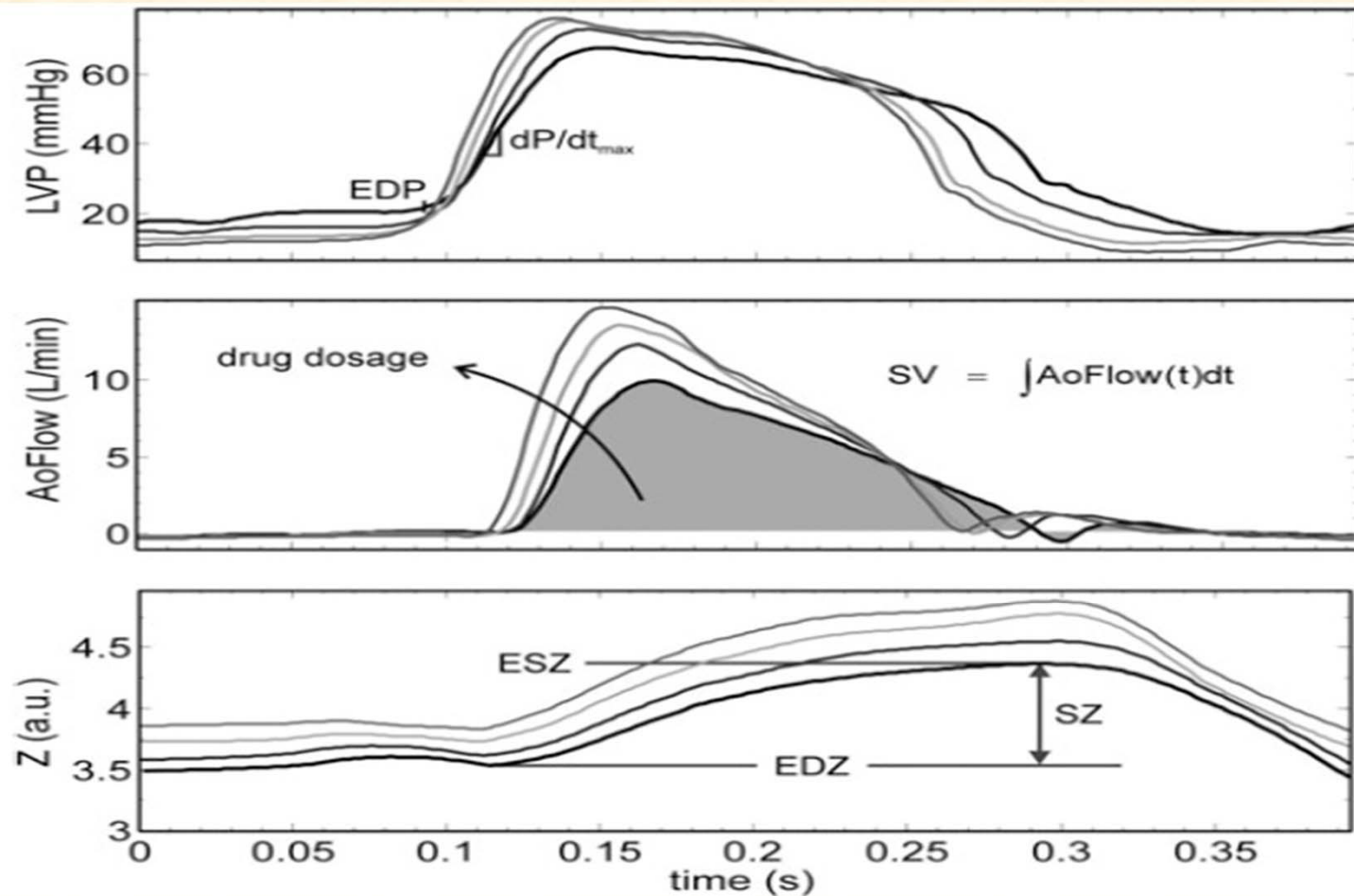
Impedance and volume

Assessing Acute Ventricular Volume Changes by Intracardiac Impedance in a Chronic Heart Failure Animal Model

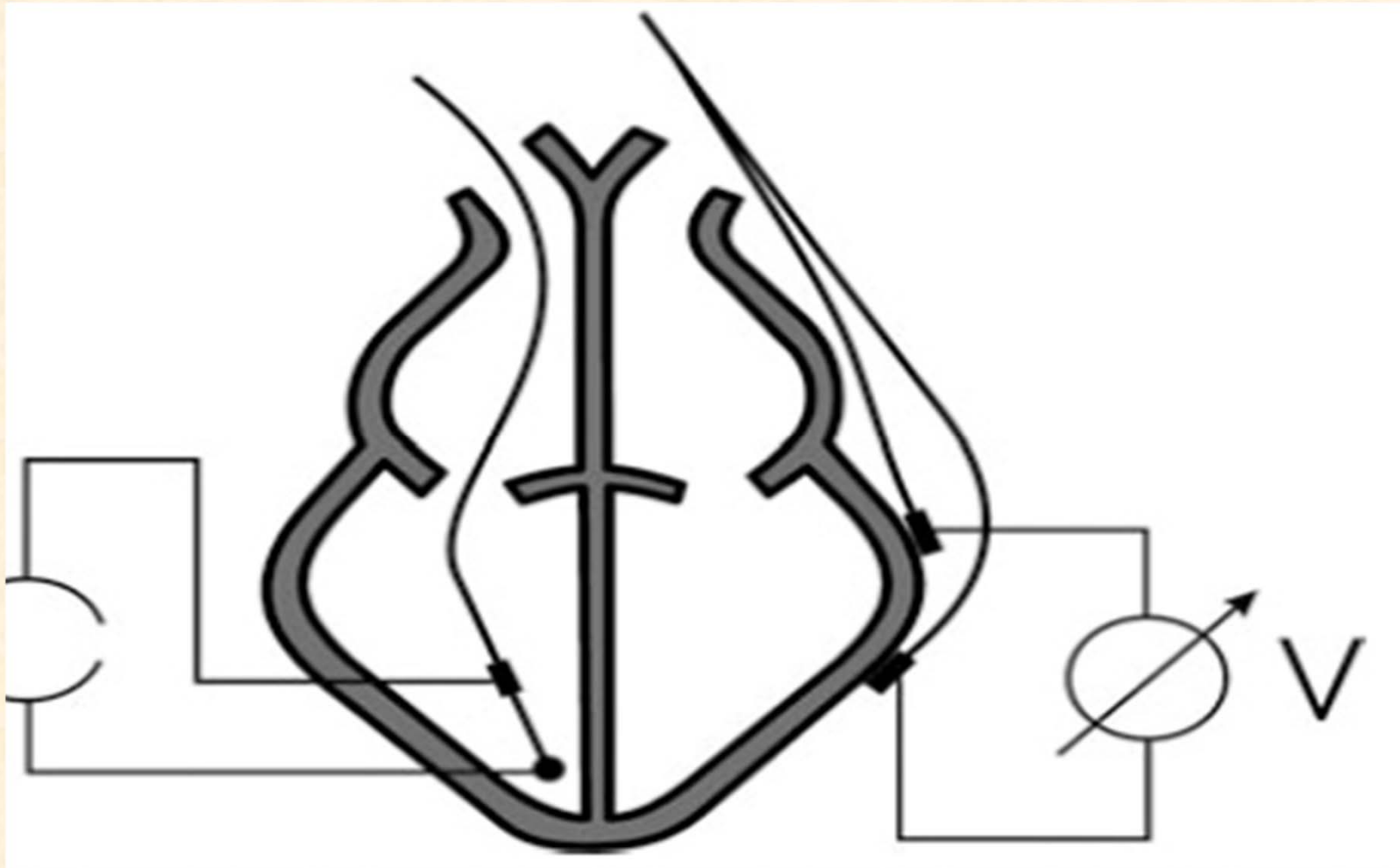
CARSTEN STAHL, M.D.,* TOBIAS WALKER, M.D.,† ANDREAS STRAUB, M.D.,†
KLAUS KETTERING, M.D.,* KAROLIN KNUBBEN, M.D.,‡ TIM O. GREINER, M.D.,§
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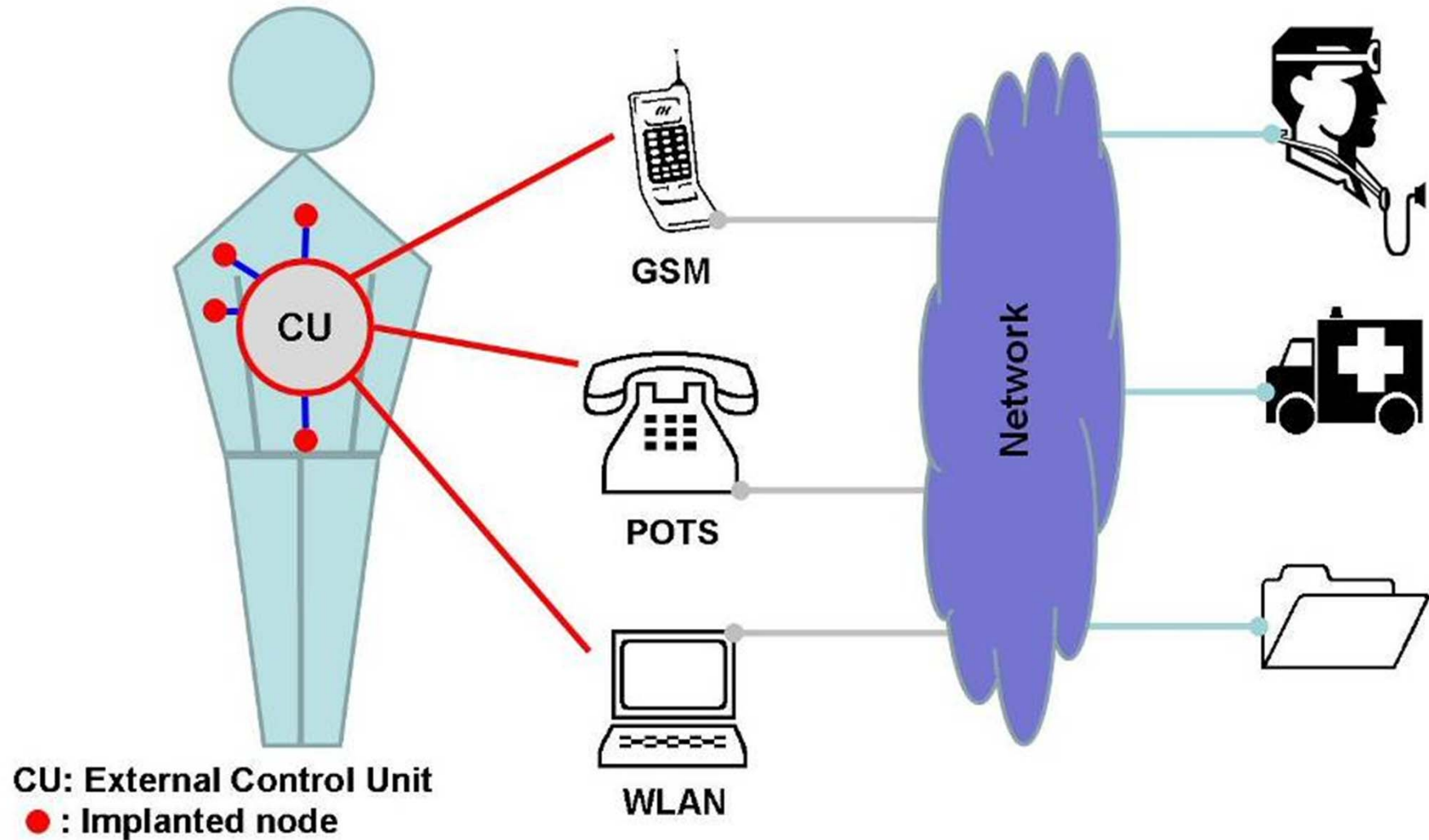
Impedance and LV function



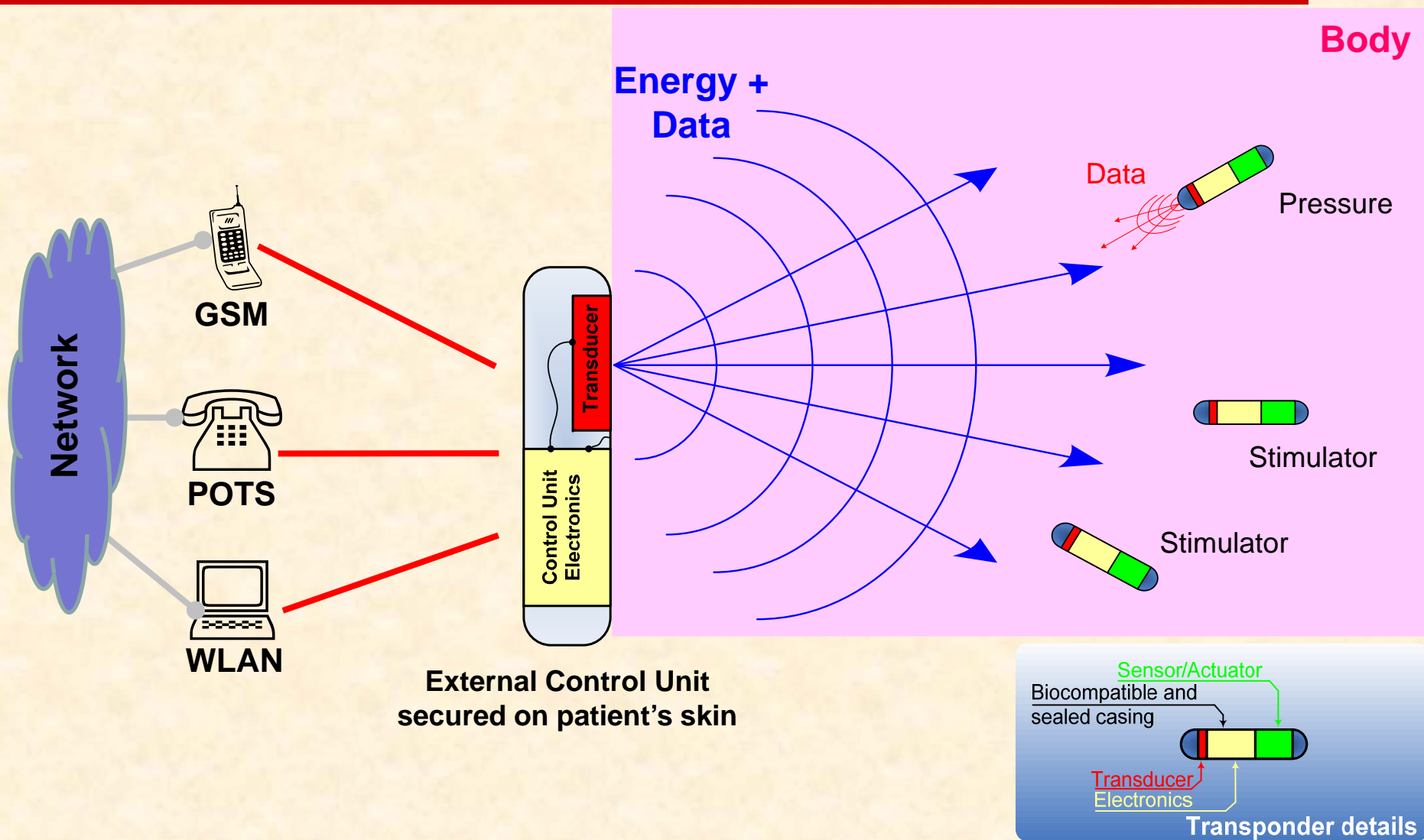
Impedance measurements



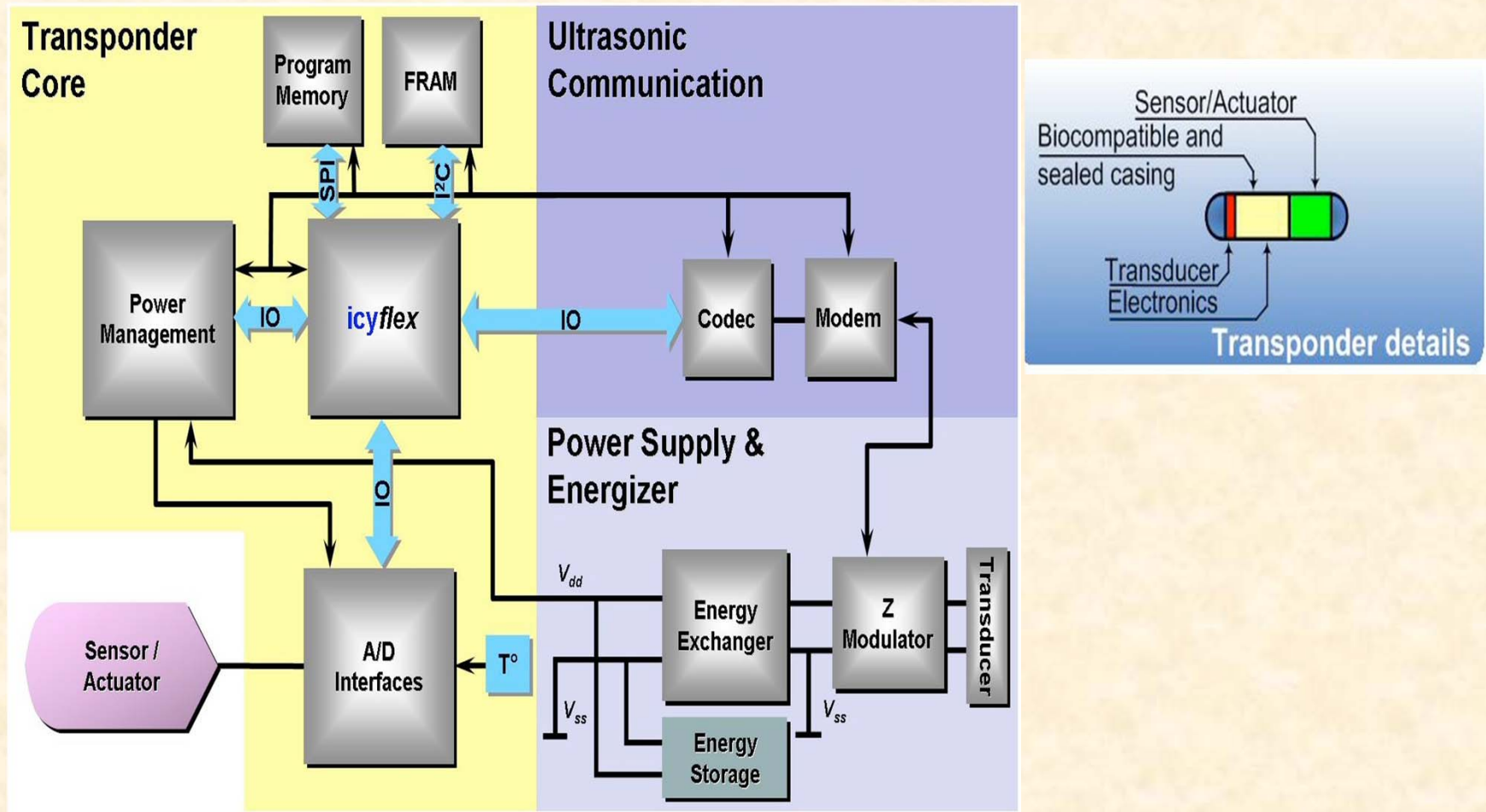
Implantable biosensing transponder network



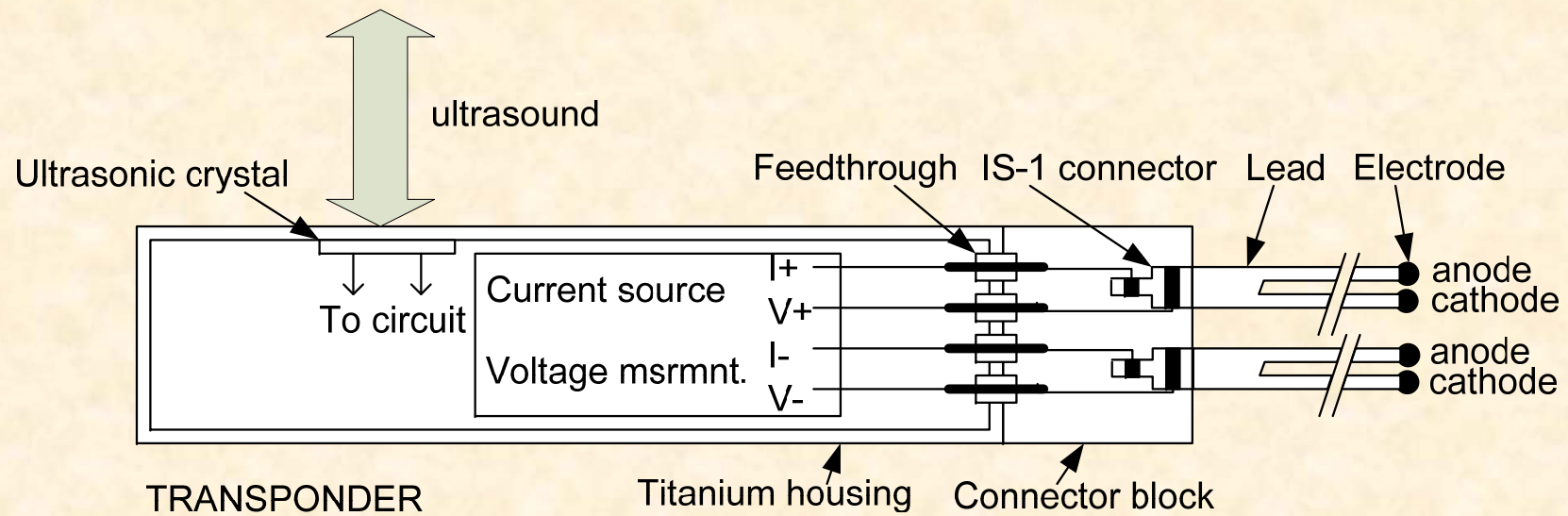
Communication between the CTRL unit and the body



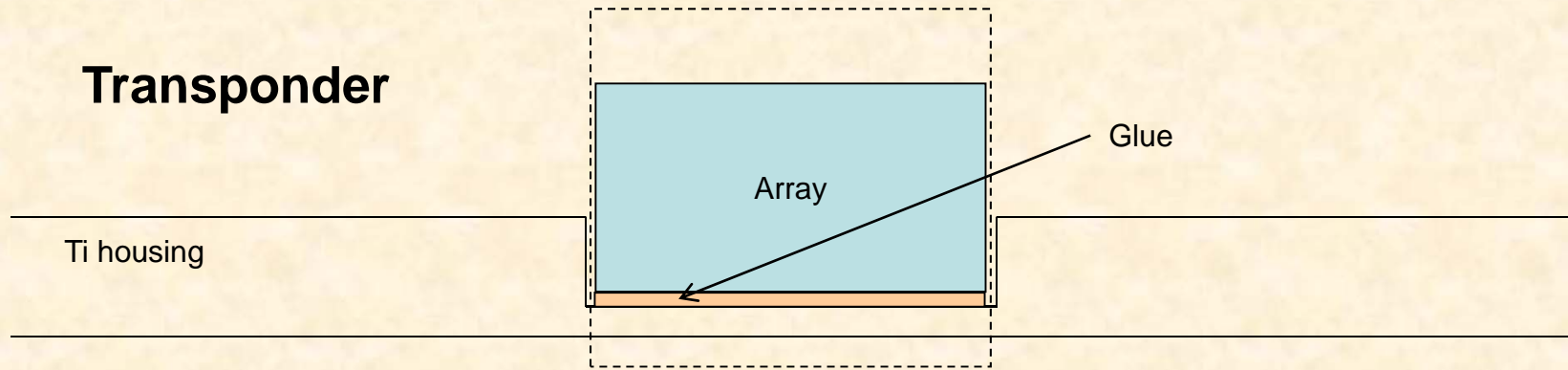
Overall Transponder System



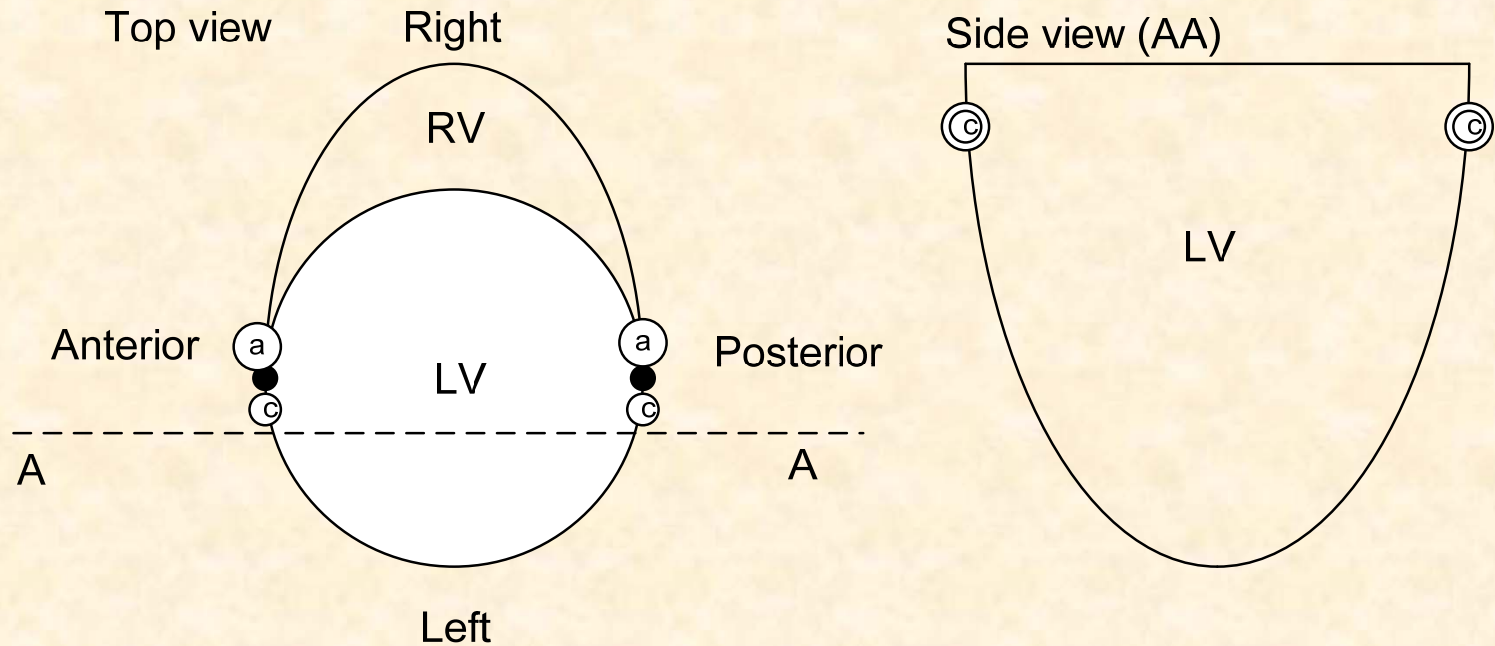
Interfaces



Ultrasound interface

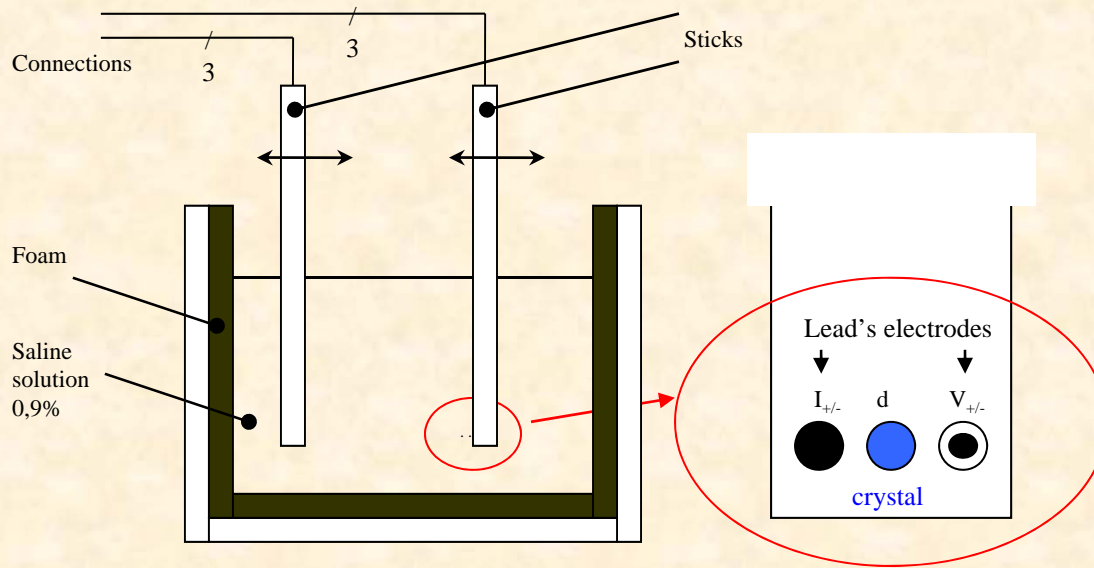


Schematic application of sensors

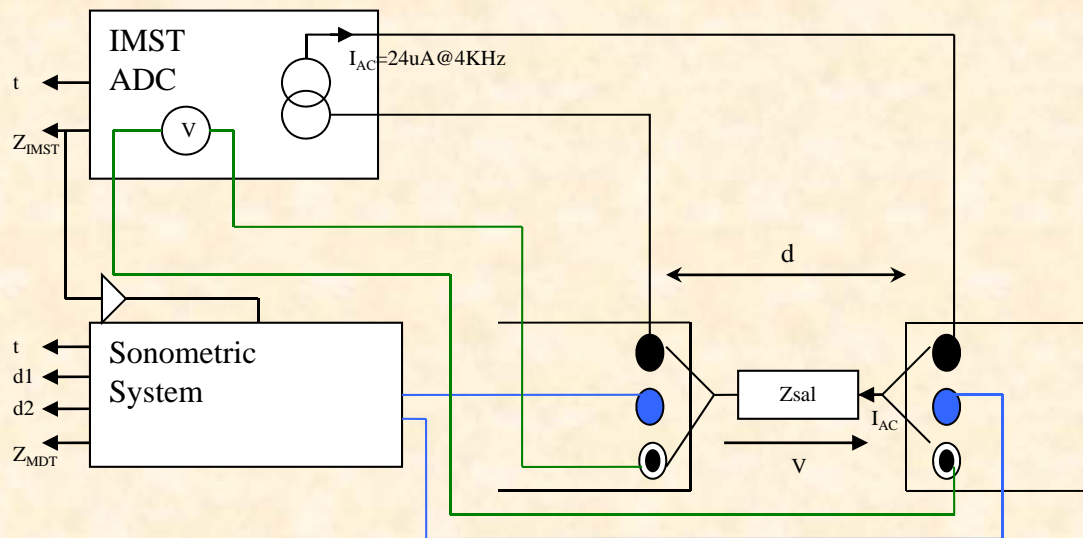


- = sonomicrometry crystal
- Ⓐ = anode
- Ⓒ = cathode

In vitro test of sensors



Using IMST breadboard

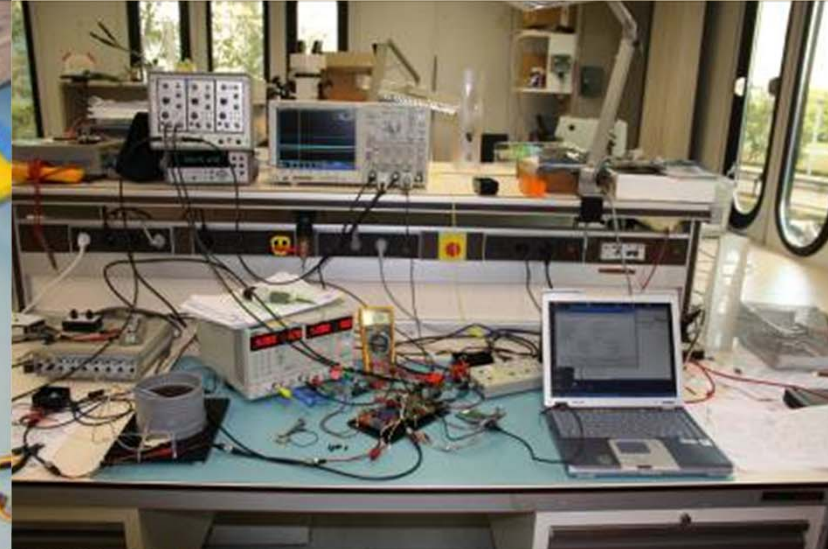
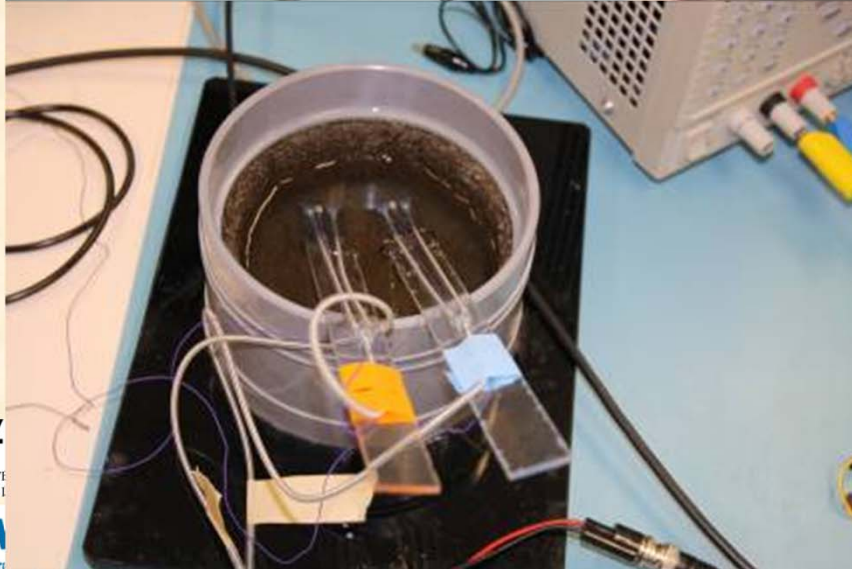
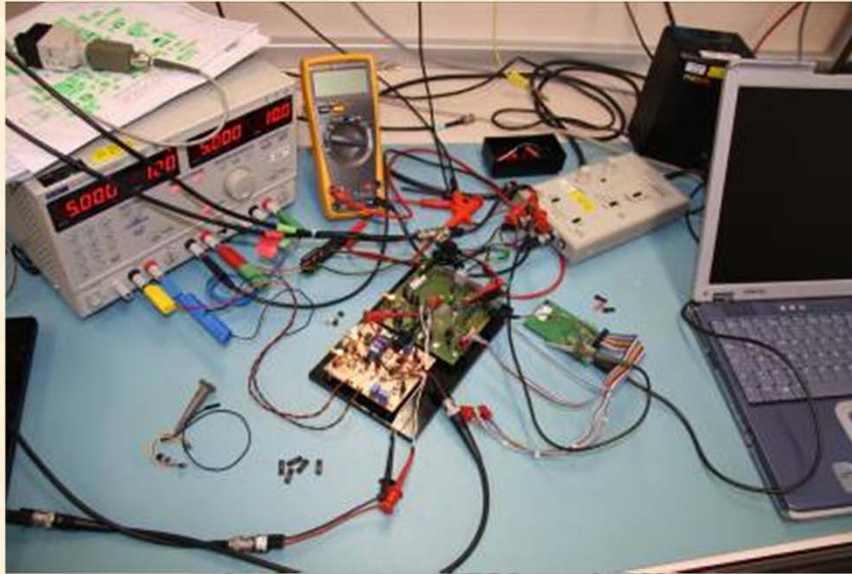


The circuitry used on this breadboard will be integrated in the animal unit and implanted

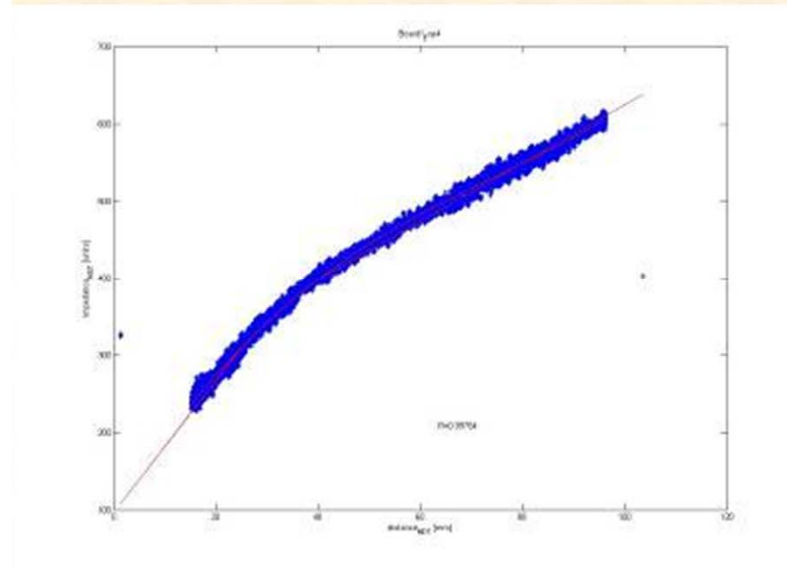
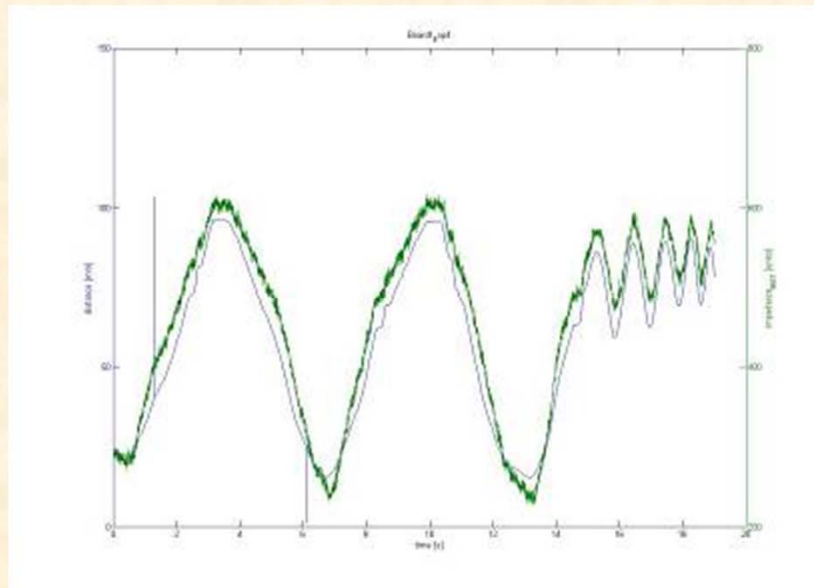
Joined testing at BRC



Pictures of experimental setup



Results



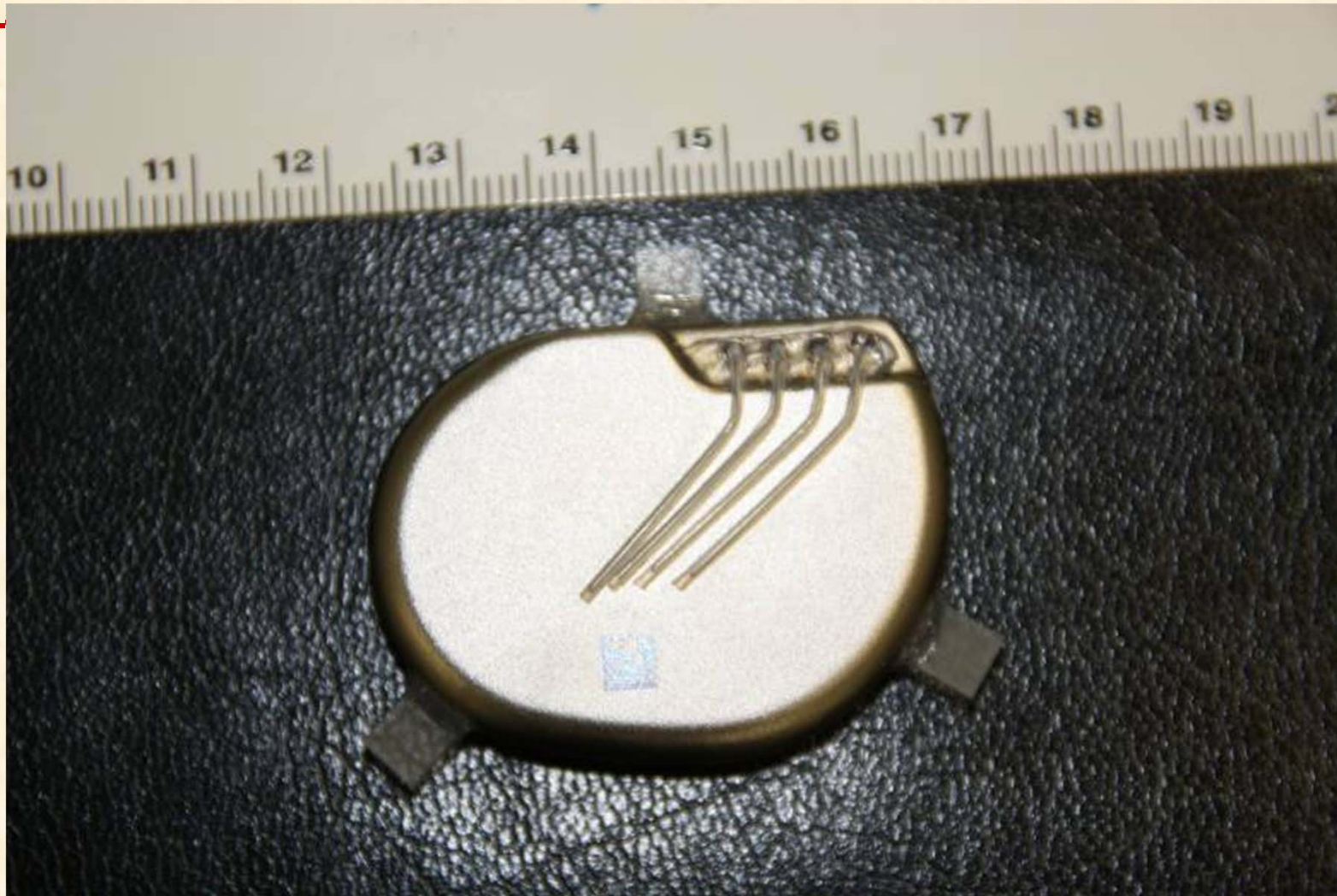
Methods, Acute Experiments

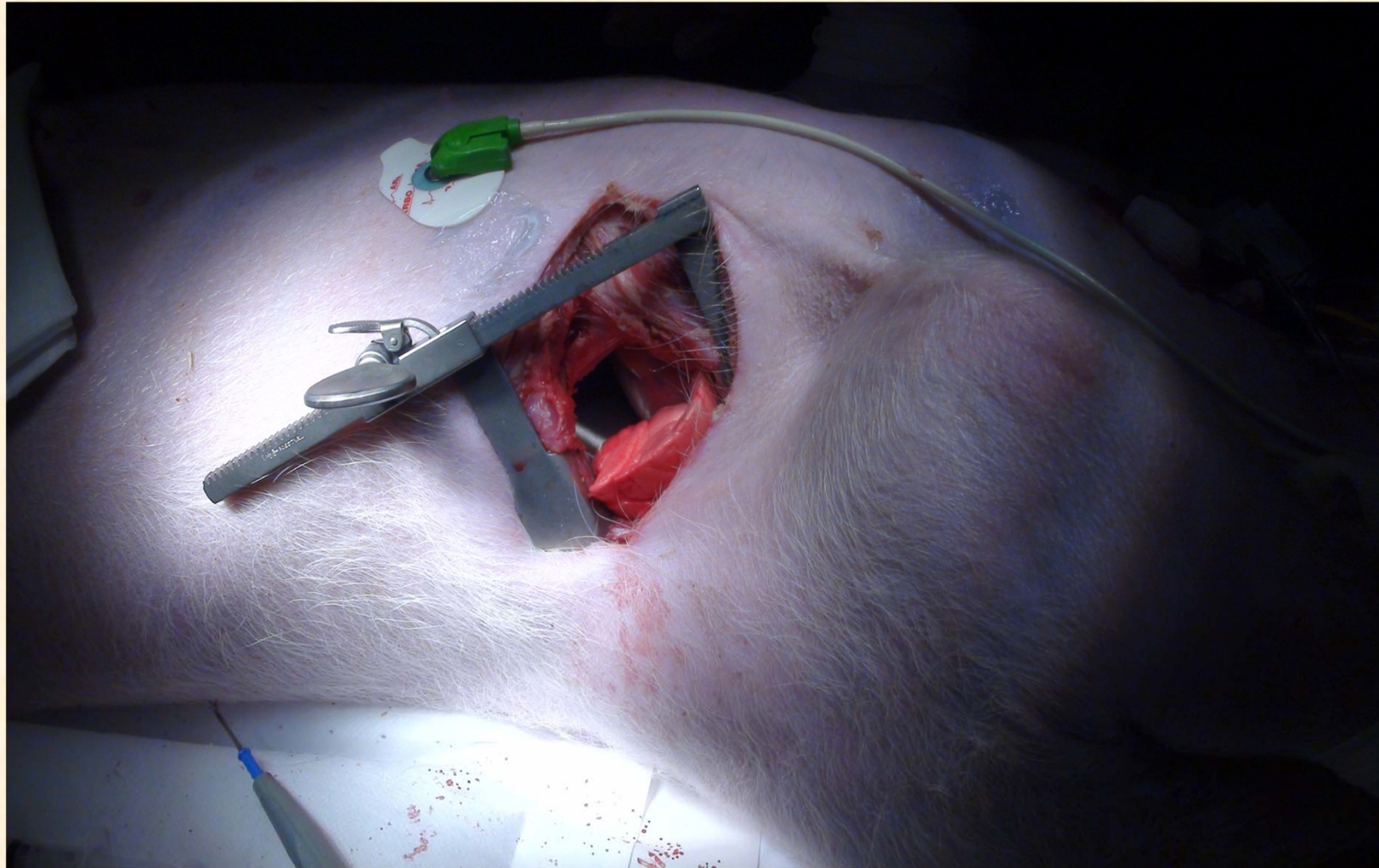
- Animals Pigs 35-50 kg
- Minimal thoracotomy for box-placement
- Placement of electrodes on LV
- Measurements of impedance
- Volume loading and unloading to measure impedance at varying loading condition of the LV
- Statistical analysis of data

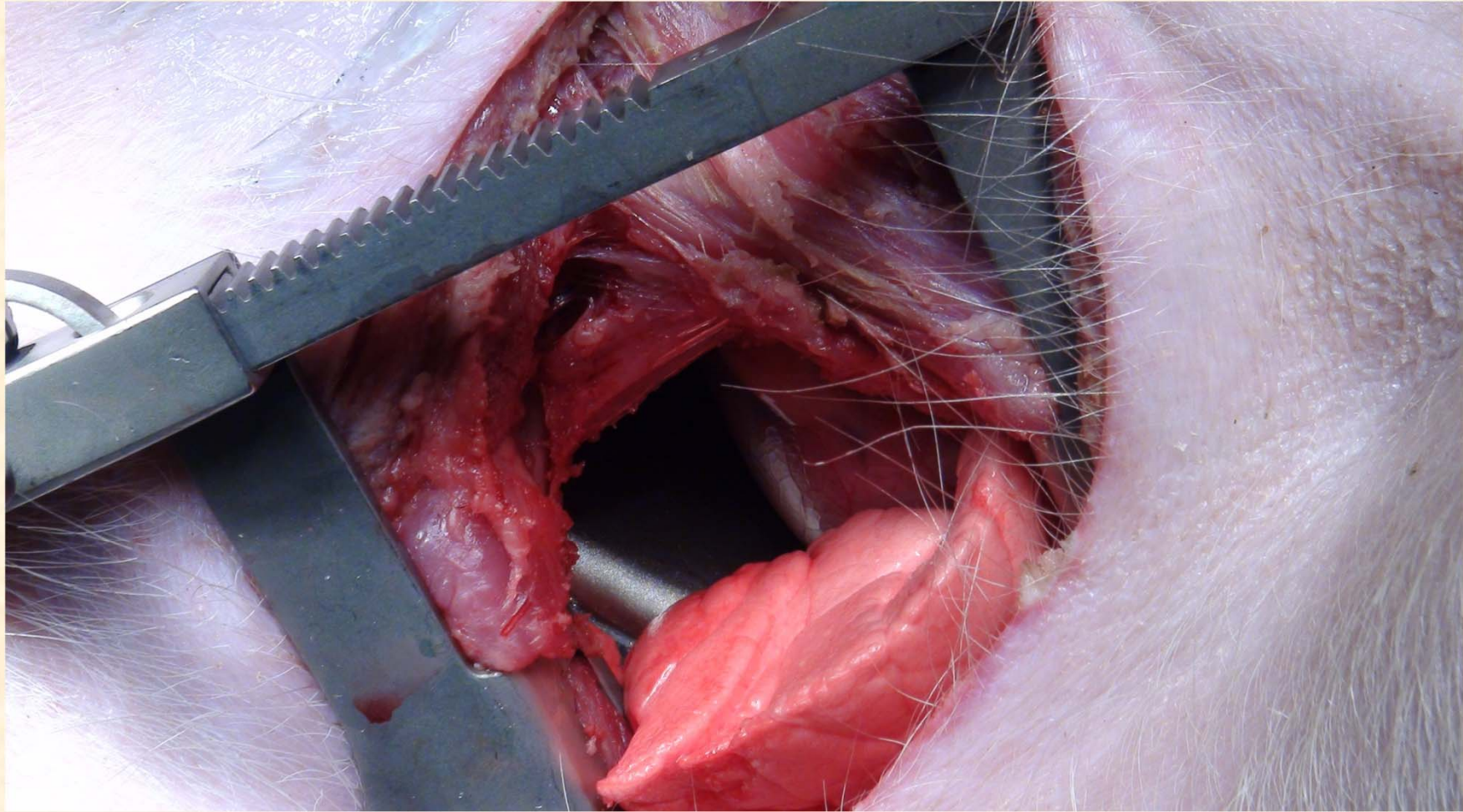
Objectives

1. Communication and transfer to device
2. Impedance measurements acute settings

Fixation of can (suture)







Methods, Chronic Experiments

- Induced Heart Failure in pigs
Long term ventricular rapid pacing
- Implantation of Ultrasponder
Monitoring of Impedance
Hemodynamic measurements
Echocardiography
- Correlation of hemodynamic, echo and impedance values

Future Prospects

Minimalization of Ultrasponder
Long term animal studies
Clinical Studies

Thank You For Your Attention



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