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Hemodynamic Bio-Impedance Model for Cardiovascular Electrical Impedance Tomography (EIT)

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Introduction

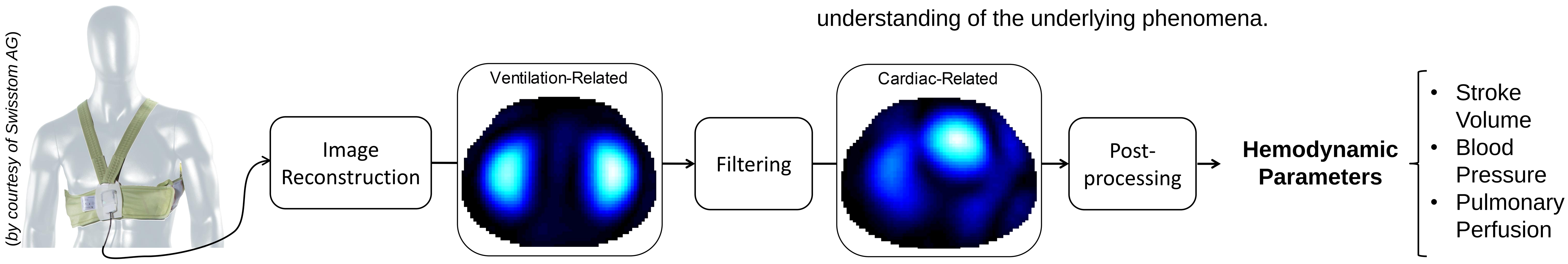
Electrical Impedance Tomography (EIT) is a functional medical imaging technique successfully used to monitor ventilation [1]. Conductivity images enable a regional analysis of lung tissue. Besides that, EIT is also an appealing candidate to measure cardiovascular-related changes [2].

Compared to other medical imaging modalities, EIT has the advantages of being non-invasive, low-cost and enables continuous bedside monitoring.

Controversial Origin of Cardiovascular EIT

In various studies [3-6], cardiovascular EIT images were used to estimate hemodynamic parameters such as blood pressure or stroke volume.

PROBLEM: However, the **exact origin of cardiac EIT signals is unclear** and there exist contradictory interpretations in the literature [7]. This lack of understanding makes it hard to develop reliable algorithms for hemodynamic parameter estimation and gives rise to gain a deeper understanding of the underlying phenomena.



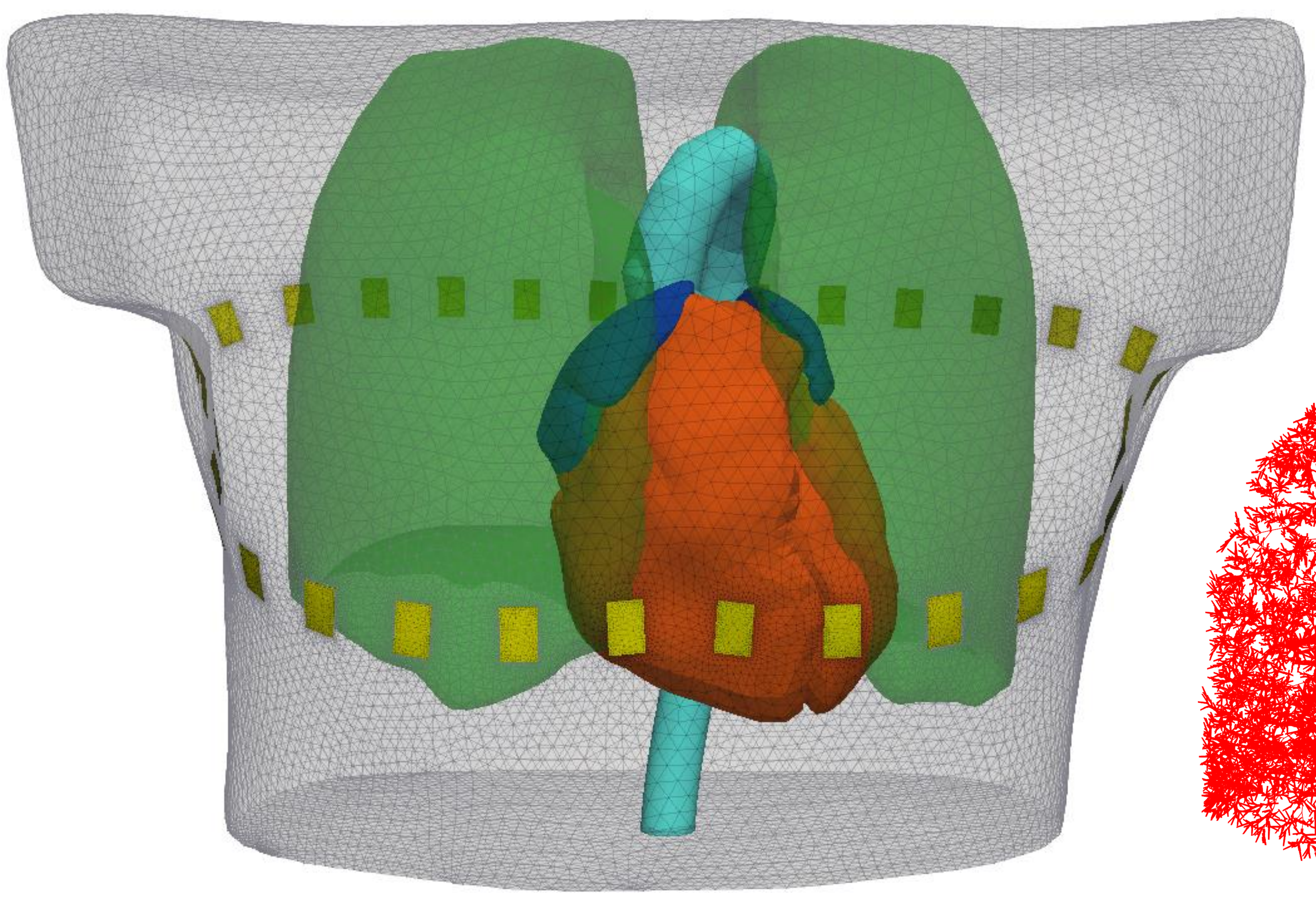
Hemodynamic Bio-Impedance Model

SOLUTION: Based on MR images, a **3D bio-impedance model** was created to simulate EIT recordings of different hemodynamic states. This dynamic model incorporates the most important electrical conductivity changes in the human thorax during expiratory breath hold.

The simulation-based approach enables to study different aspects of cardiovascular EIT in a controlled environment, ex-vivo.

Based on simulations we aim to :

- evaluate the feasibility of **estimating hemodynamic parameters**
- **optimize** the EIT **electrode placement**
- investigate the **contribution** of **every organ** to the EIT images
- investigate the **influence** of **electrode movement**

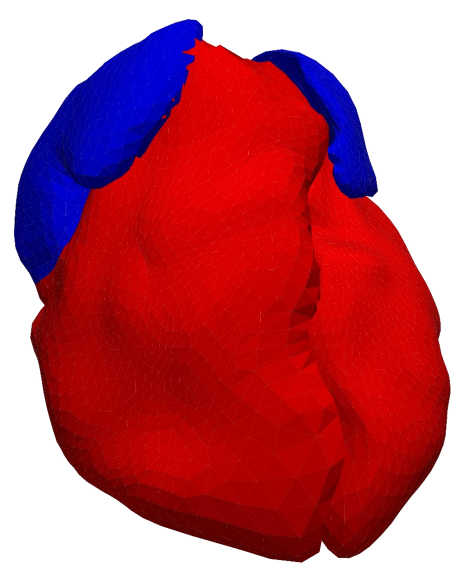


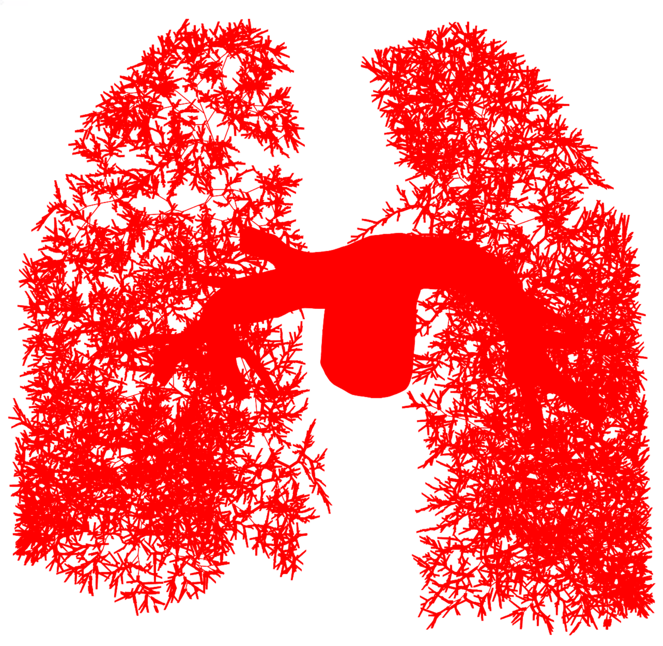
3D bio-impedance model of the human thorax

HEART MODEL

→ Ventricular and atrial blood volume changes

- Stroke Volume and Cardiac Output
  First results in a 2.5D model show promising results for EIT-derived stroke volume estimation [8].



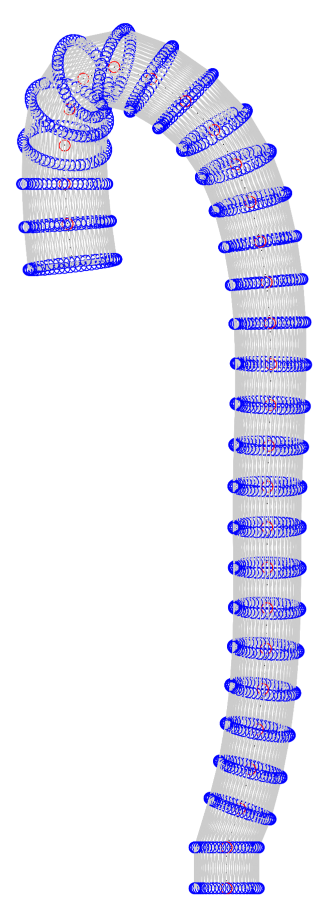


LUNG MODEL

→ Detailed representation of the pulmonary circulation

- Pulmonary Blood Pressure / Hypertension
- Pulmonary Perfusion

Work in progress…



AORTA MODEL

→ Aortic distension and movement caused by the blood pressure pulse travelling along the aortic tree

- Systemic Blood Pressure
  The detection of aortic signal strongly depends on the reconstruction algorithm [9].
- Stroke Volume (indirect approach)

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