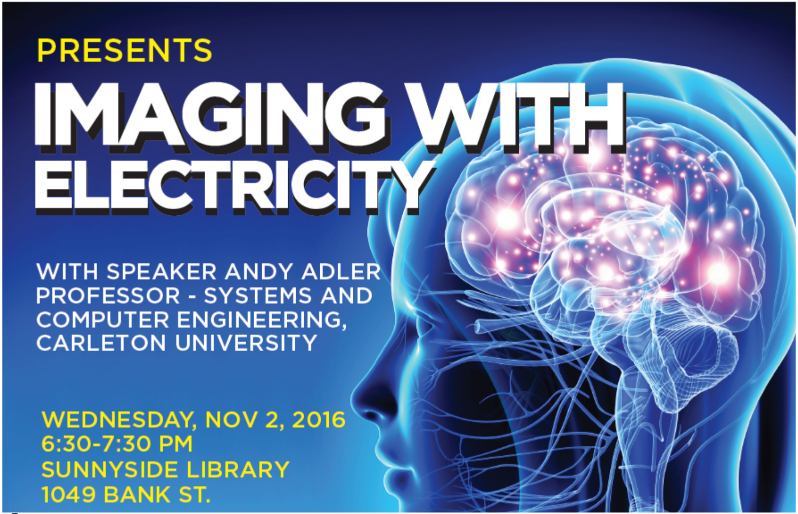
Faculty of Engineering and Design
CARLETON UNIVERSITY

ingenious TALKS



Tomography
$\triangleq$ imaging by sections

τόμος tomos, "slice, section"
γράφω graphō, "to write"

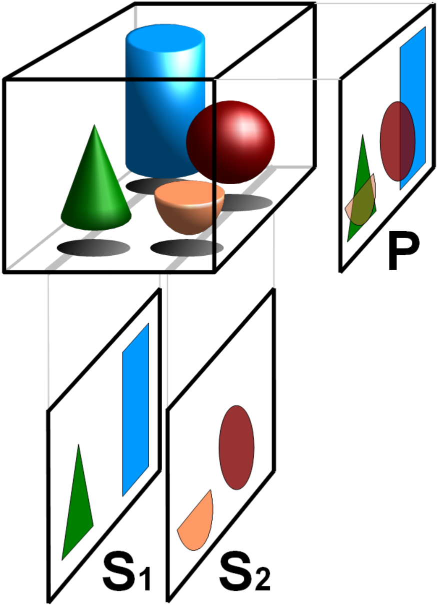
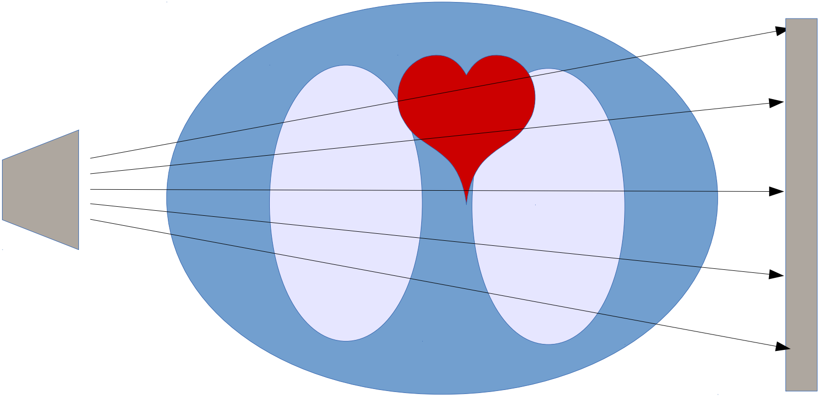
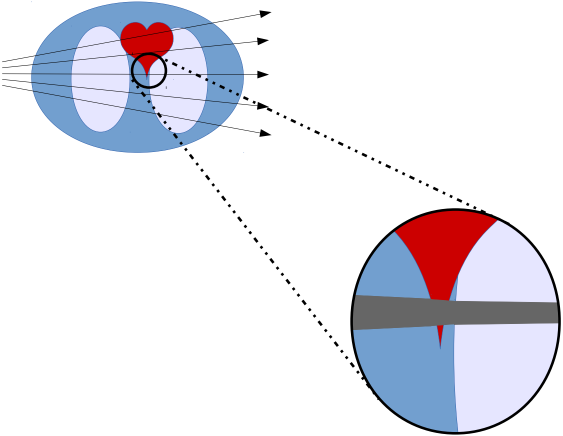


Image: By Dtrx, CC BY-SA 3.0 de, wikimedia

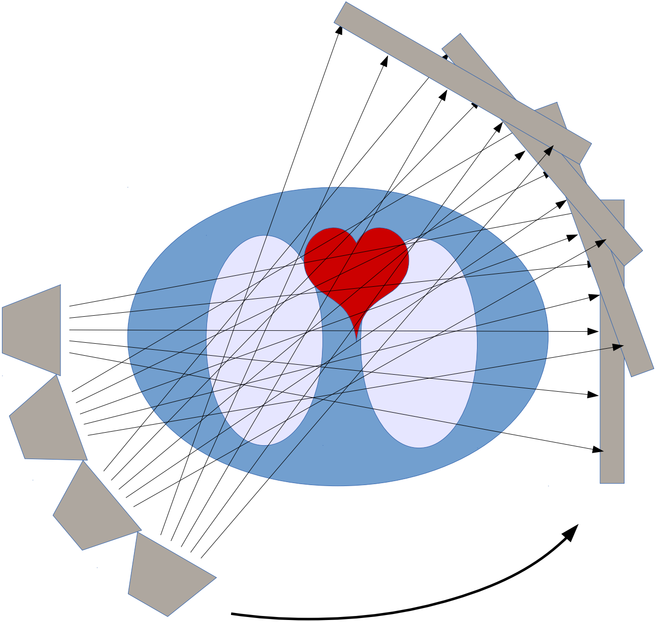
X-ray



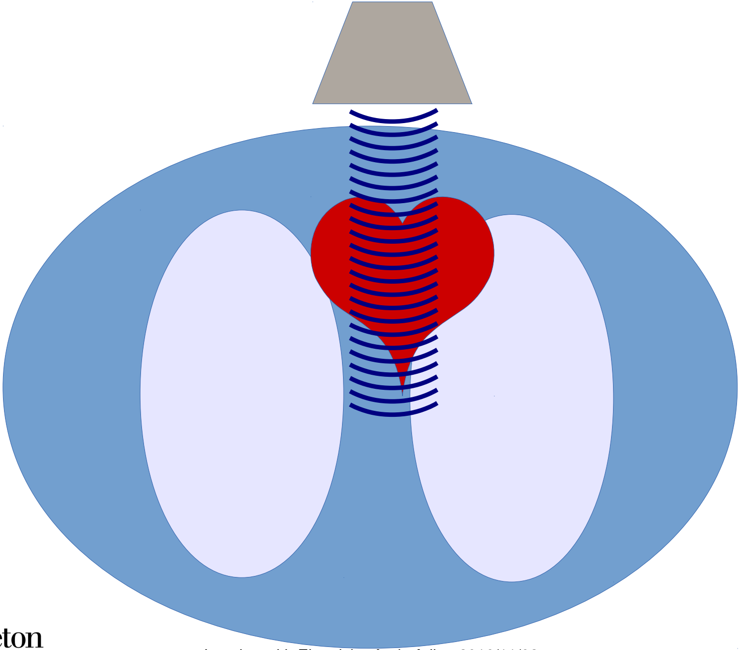
X-ray energy and the body



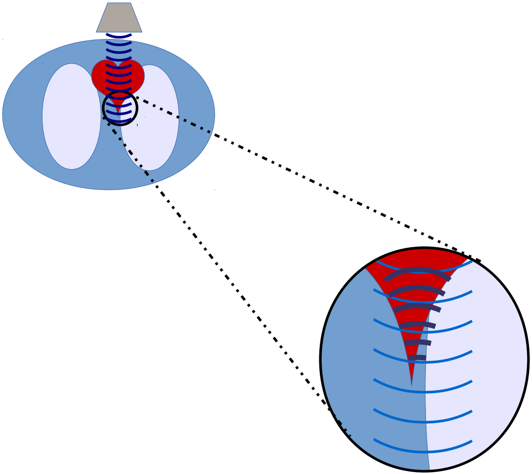
X-ray Computed Tomography — CT or CAT



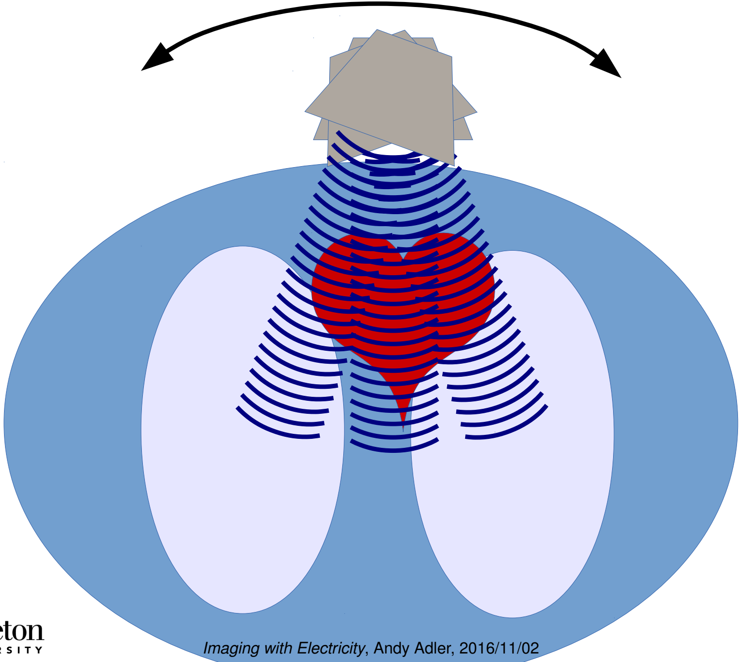
Ultrasound



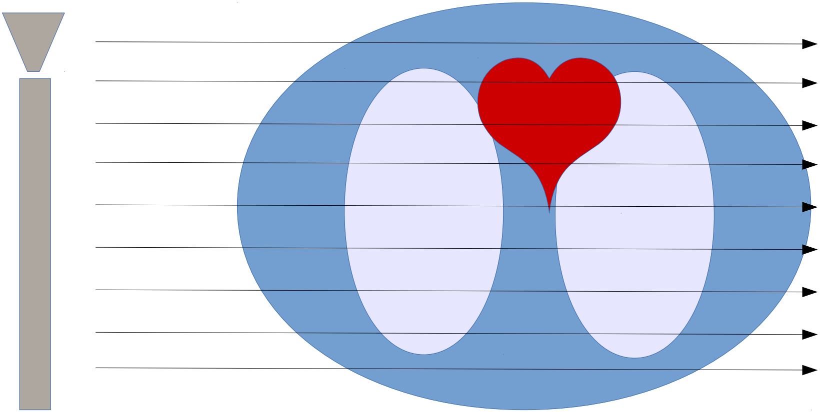
Ultrasound energy and the body



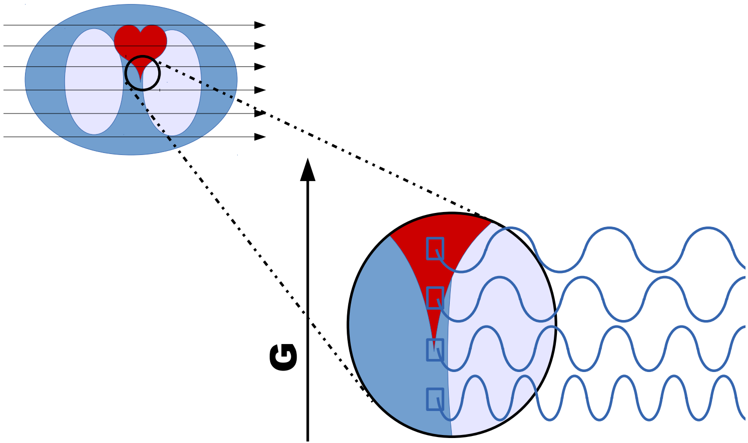
Ultrasound — imaging



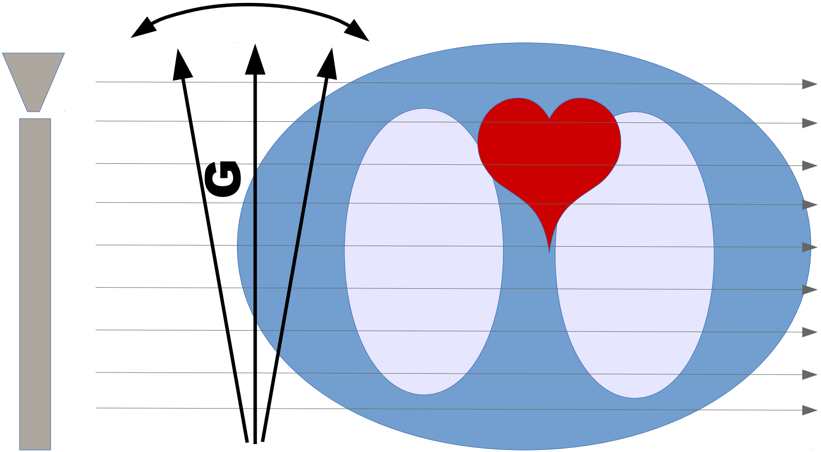
MRI — Magnetic Resonance Imaging



MRI and the body



MRI — imaging*



* One way to do it

Images and the body

Modality	Energy	Interaction
X–ray	High energy light	Attenuation
Ultrasound	High frequency sound	Reflection
MRI	Radio waves	N. Magnetic Resonance

Images and the body

Modality	Energy	Interaction
X–ray	High energy light	Attenuation
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MRI	Radio waves	N. Magnetic Resonance
Electrical	Electricity	Resistance

Ohm's Law

$$V = IR$$

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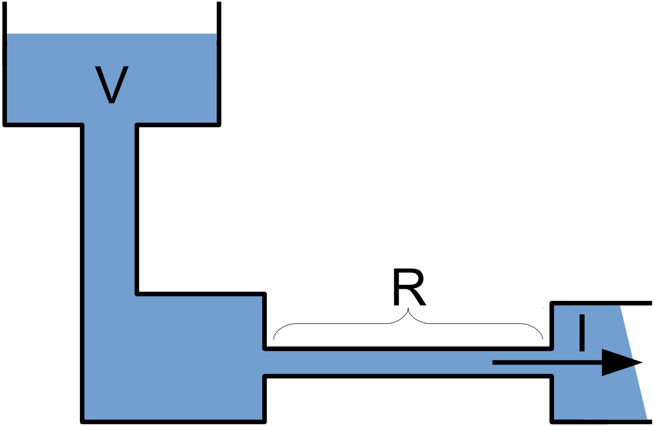
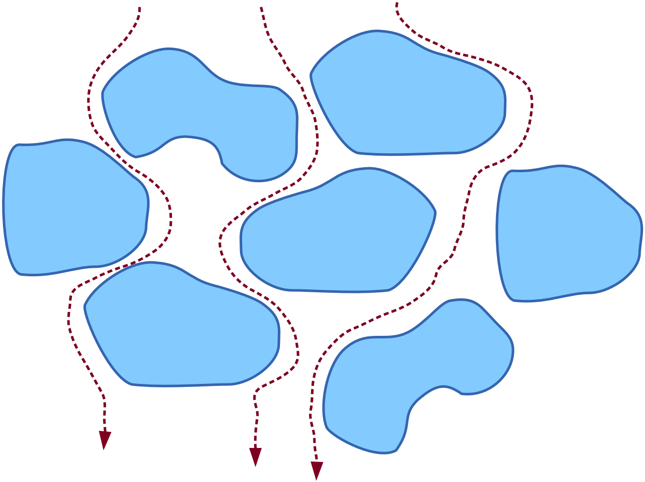
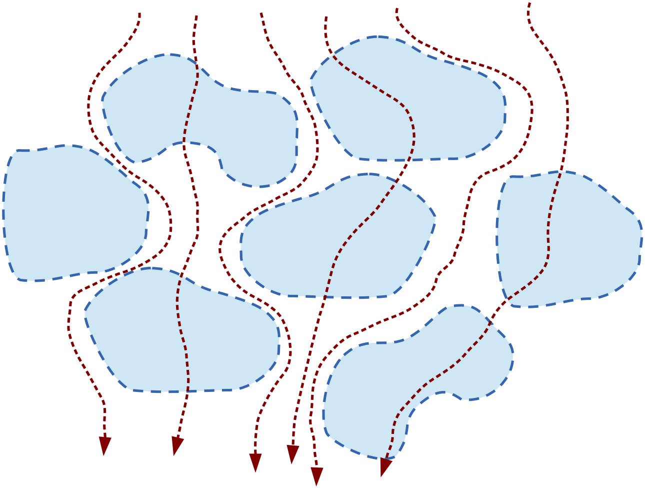


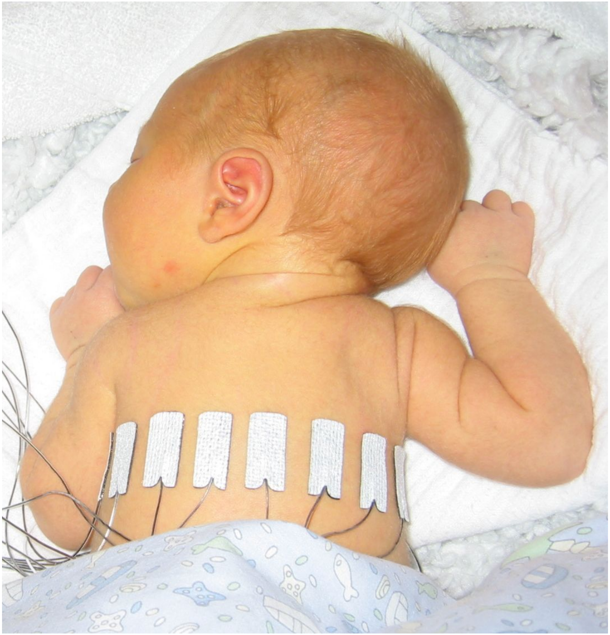
Current flow in tissue — Low Frequency



Current flow in tissue — High Frequency



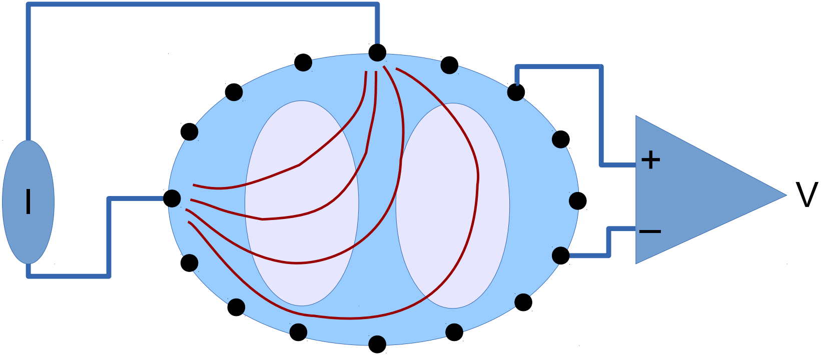
Electrical Impedance Tomography (EIT)



10-day old healthy baby with EIT electrodes

Source: eidors3d.sf.net/data_contrib/if-neonate-spontaneous

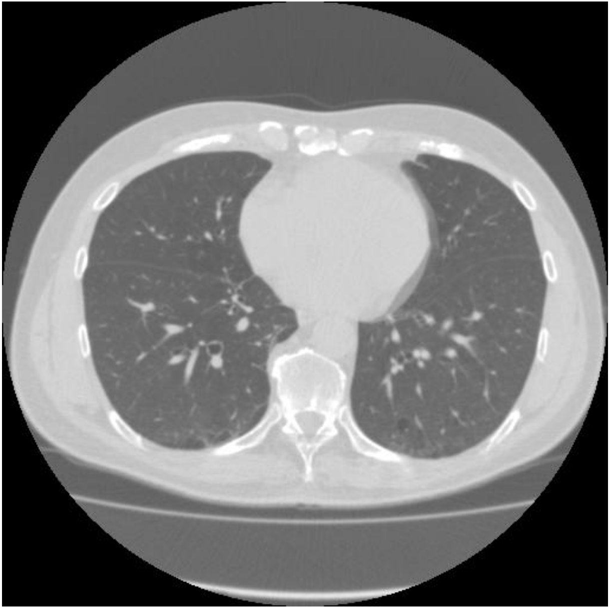
EIT – electrical stimulation and measurements



Current Propagation

Healthy Adult Male
CT slide at heart

Source:
eidors3d.sf.net/tutorial/netgen/extrusion



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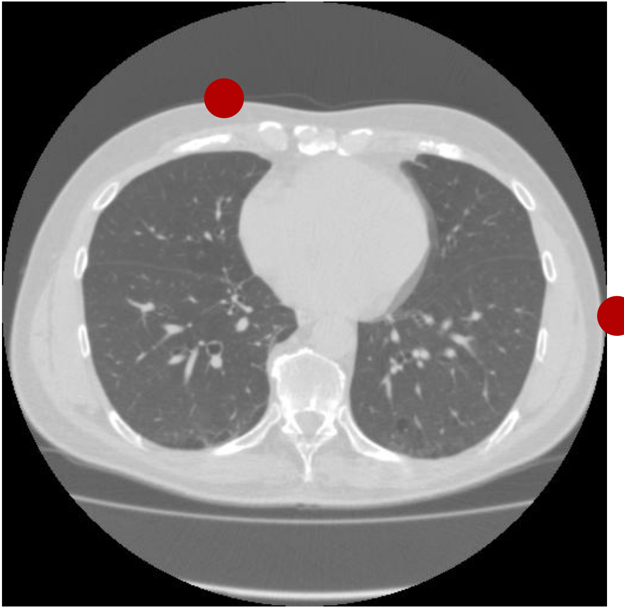

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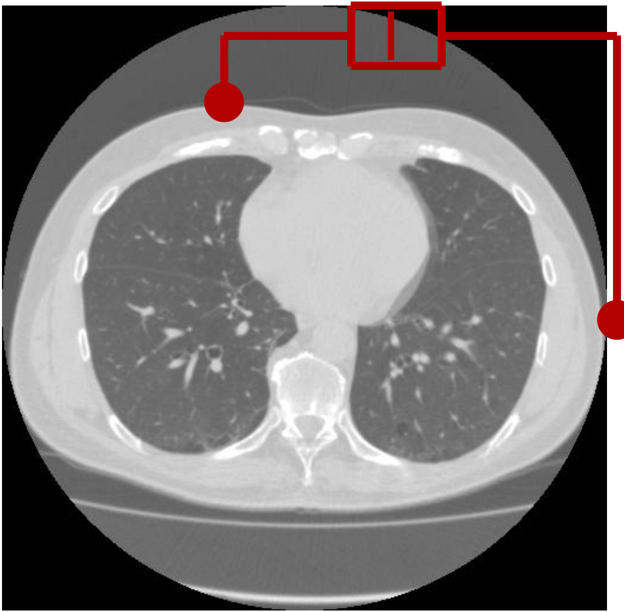

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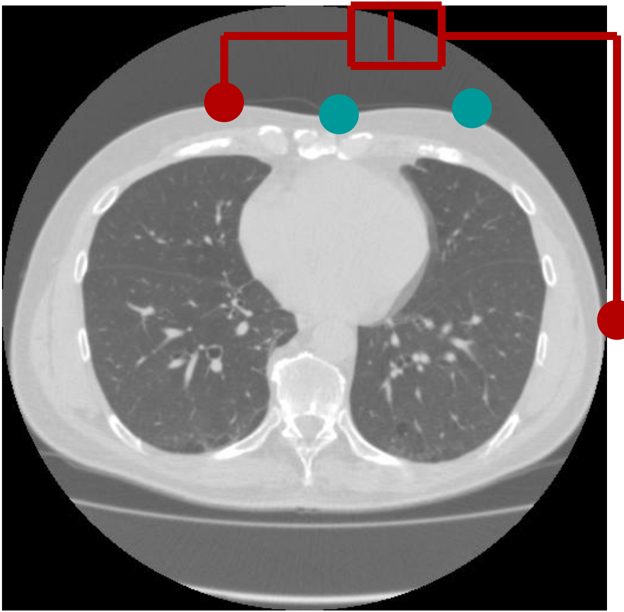

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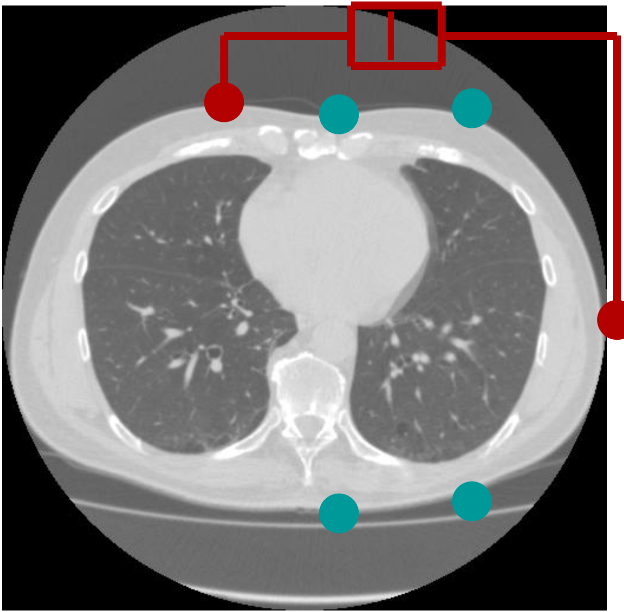
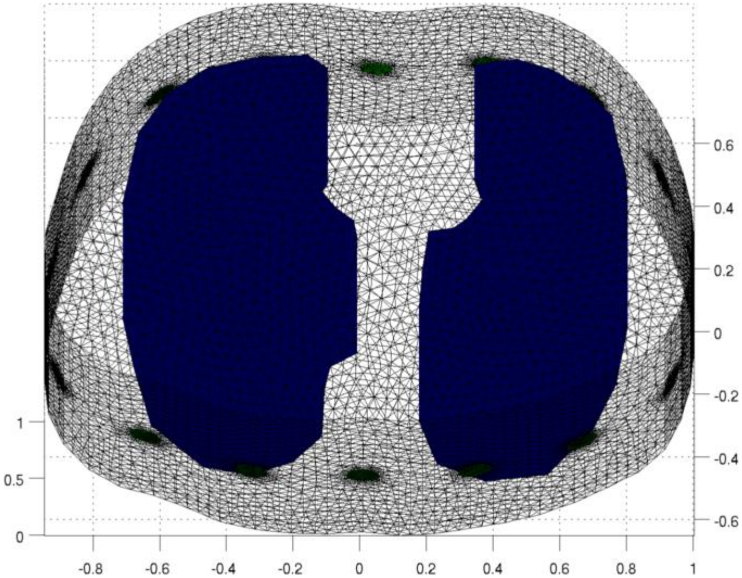
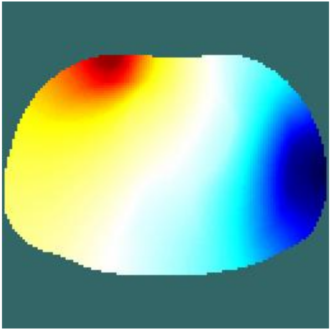


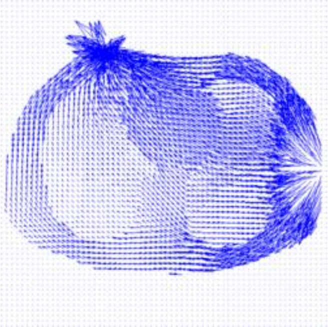
Finite Element Modelling



Finite Element Modelling



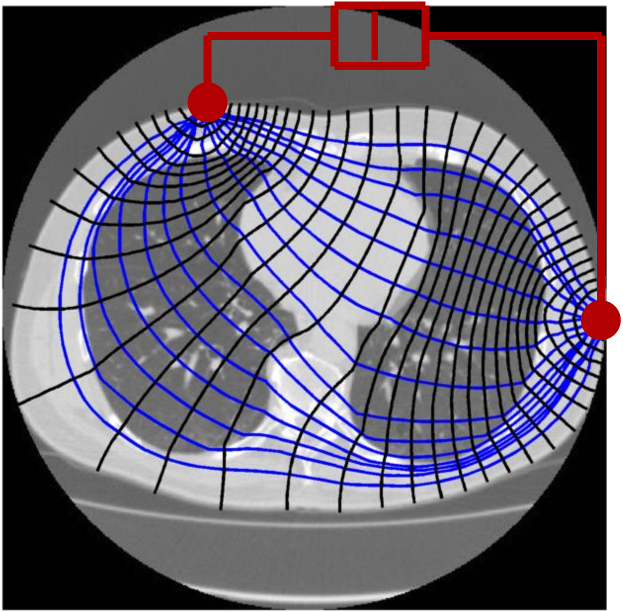
Simulated Voltages



Voxel Currents

Thorax Propagation

CT Slice with simulated current streamlines and voltage equipotentials



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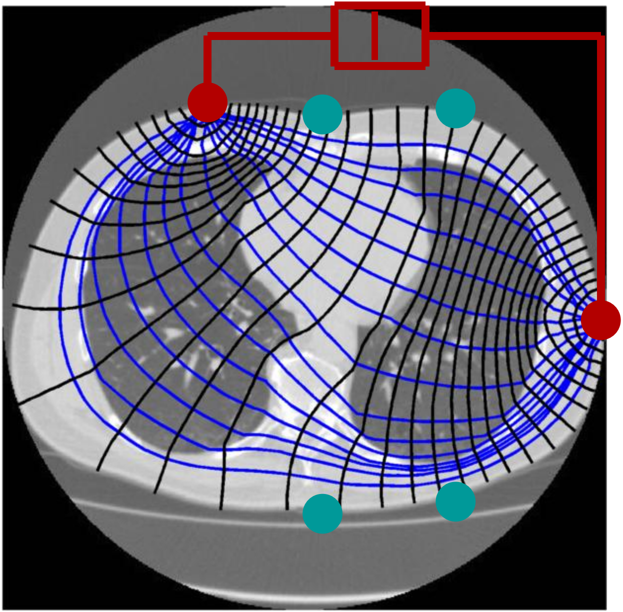
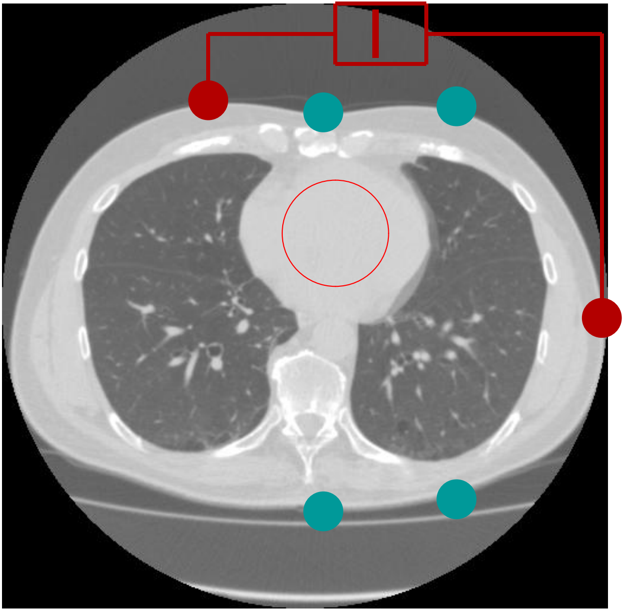


Changing Conductivity

Heart receives blood (diastole) and is more conductive



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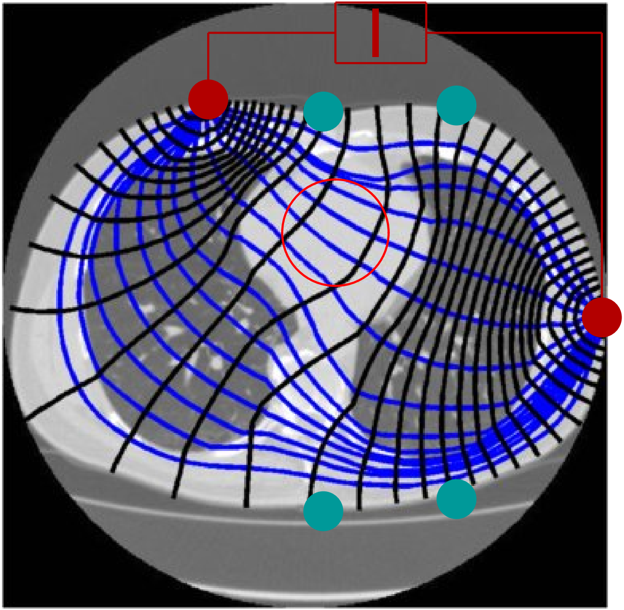

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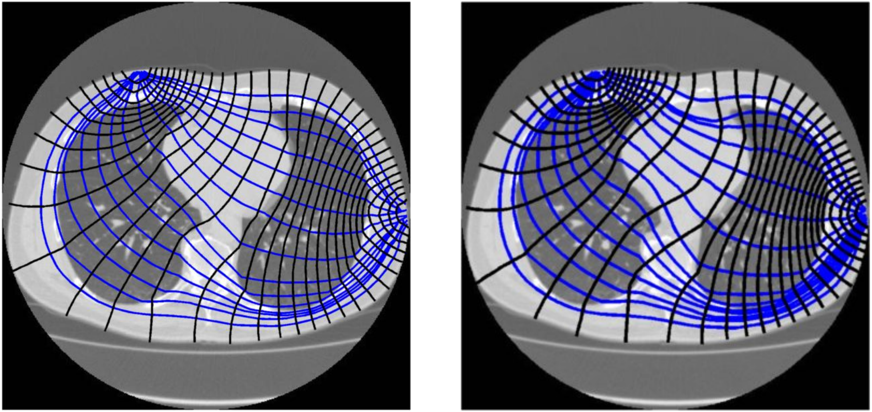
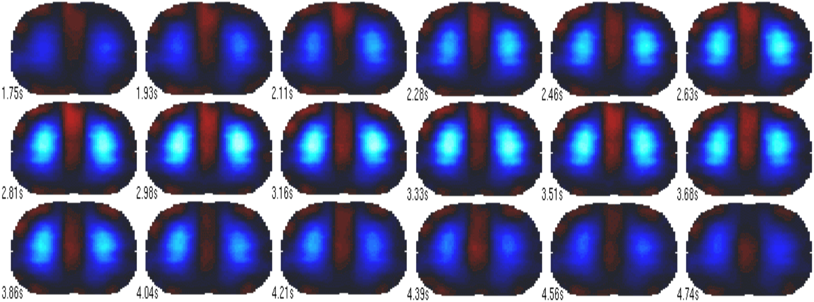
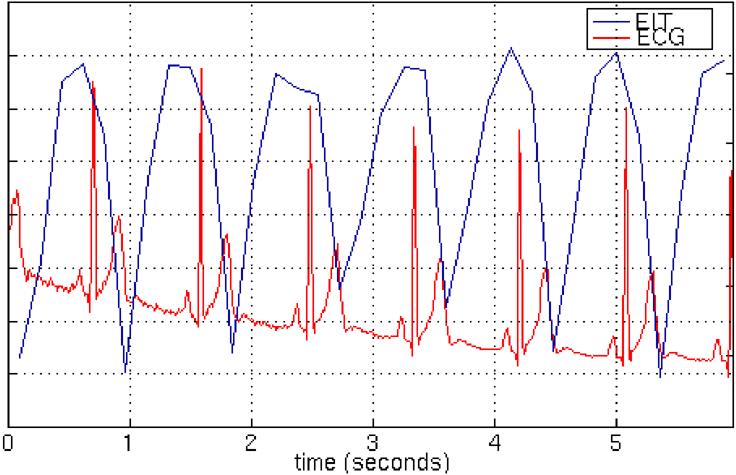


Application: Breathing



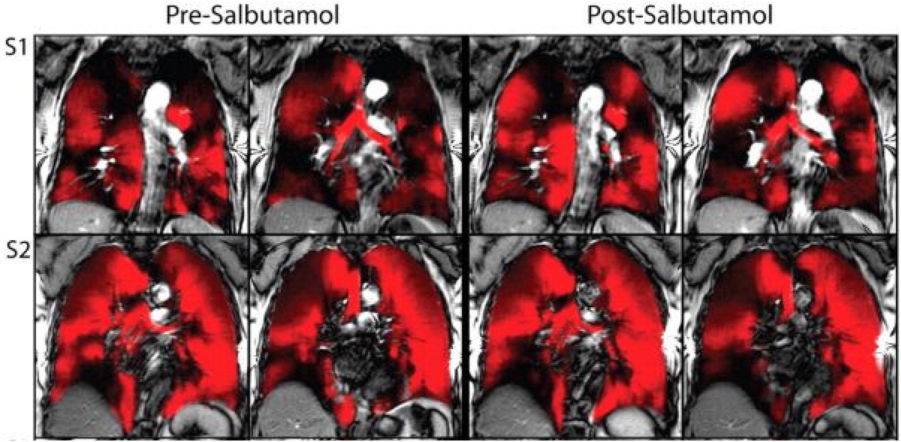
Chest images of tidal breathing in healthy adult

Application: Heart



EIT Signal in ROI around heart (and ECG)

Lung Heterogeneity

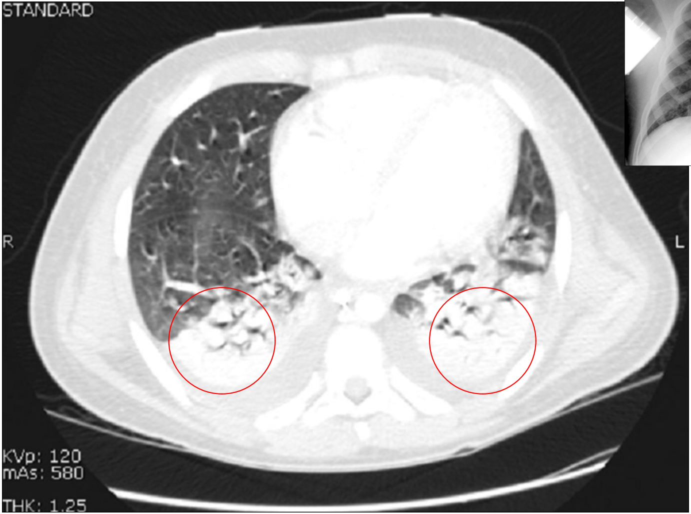


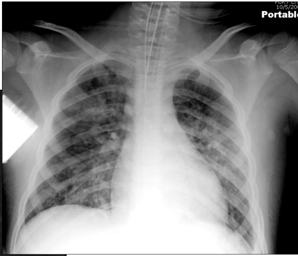
Source: Kirby et al, Radiology 261.1 (2011): 283–292.

Mechanical Ventilation and EIT monitor

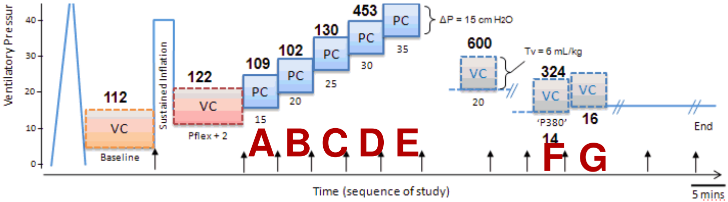
Source: Swisstom.com

Acute Respiratory Distress Syndrome (ARDS)





EIT + Lung State



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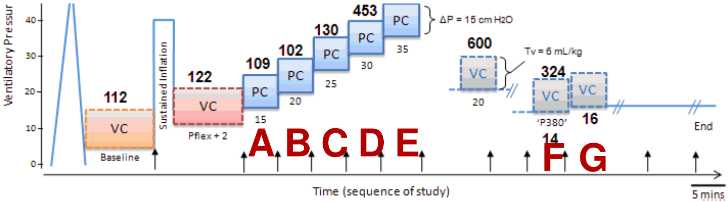

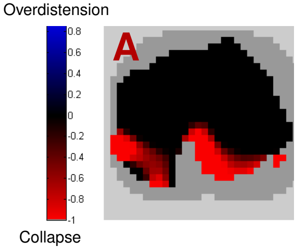

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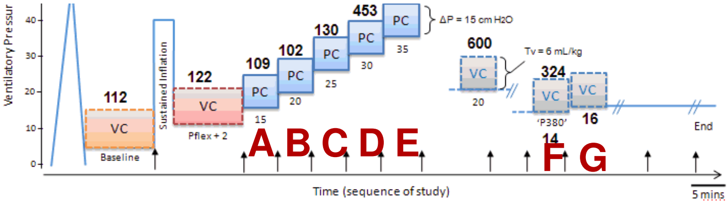

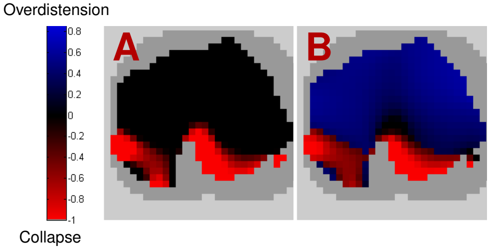

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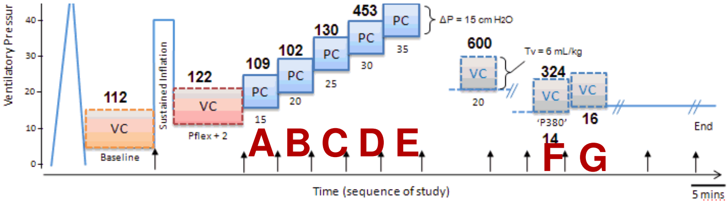

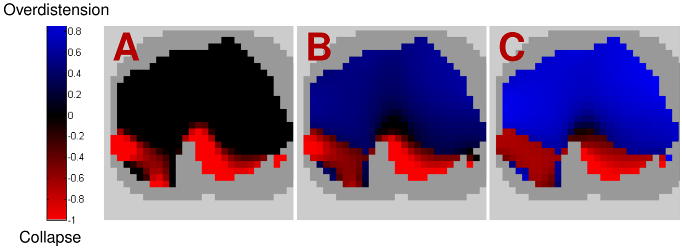

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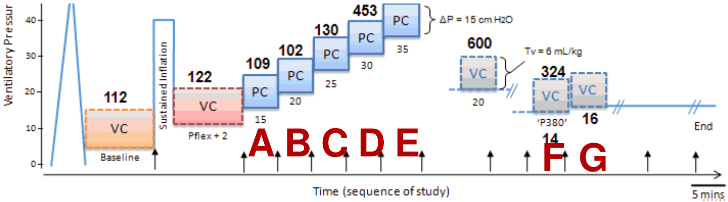

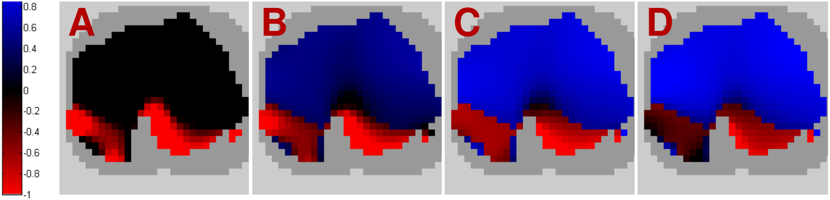

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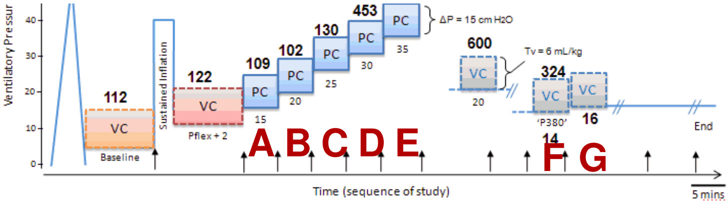

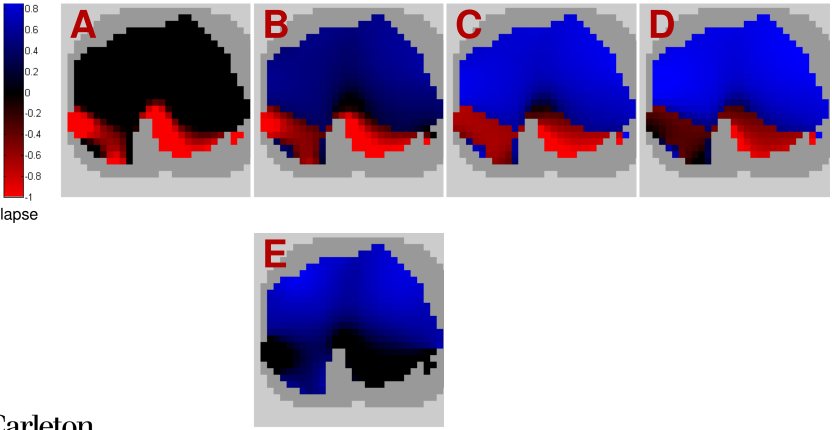

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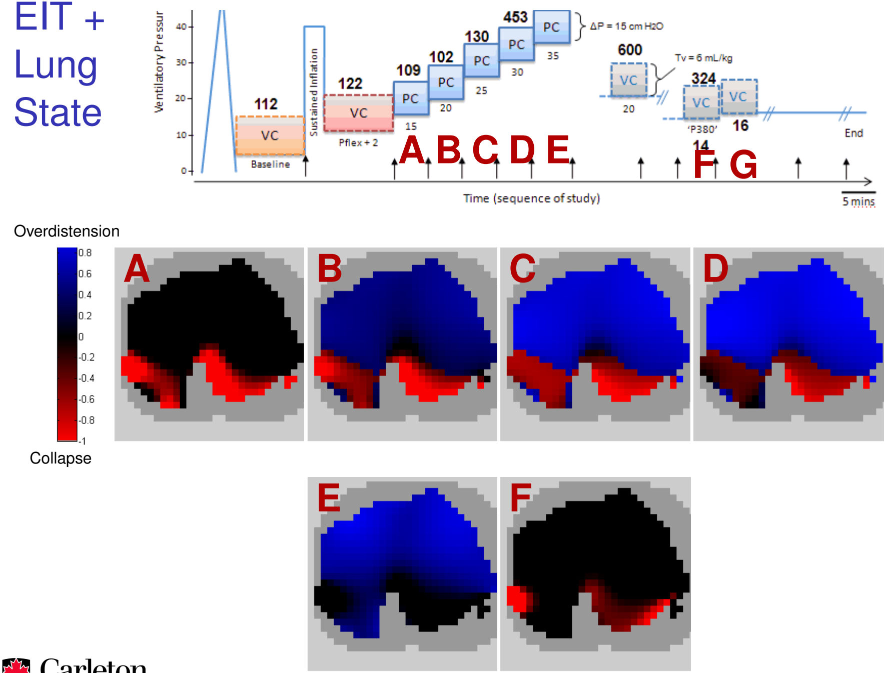

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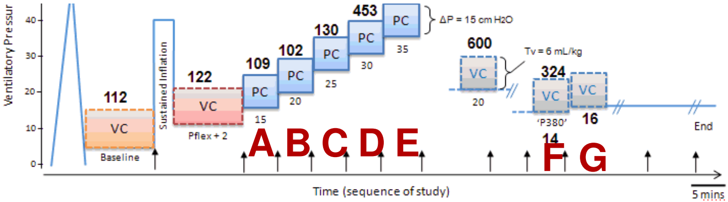
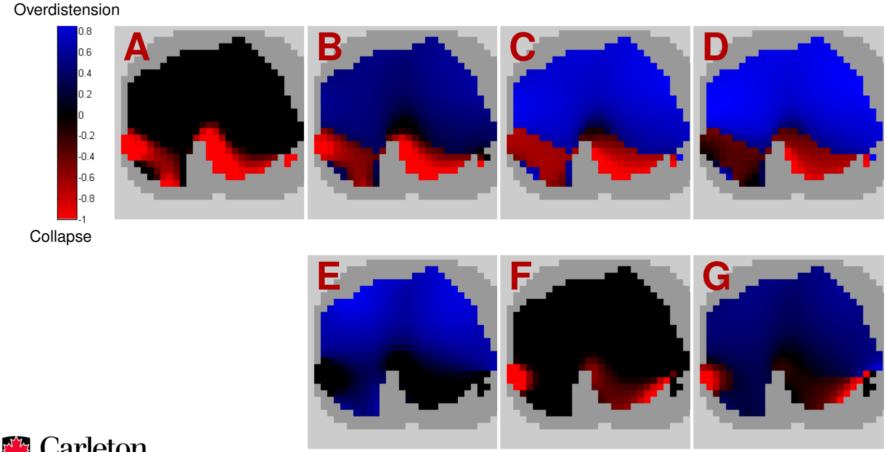
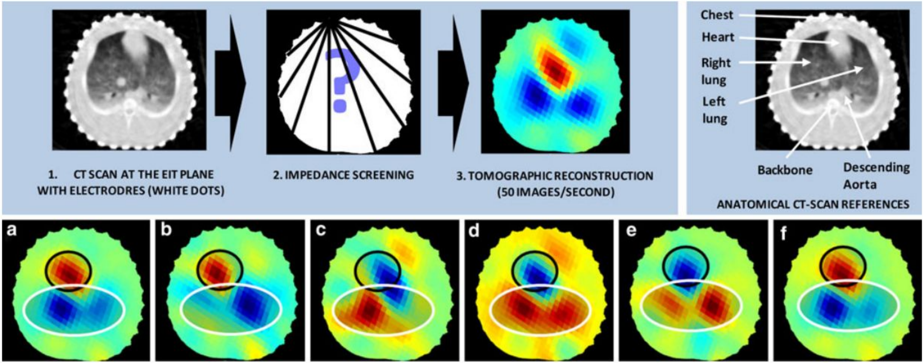


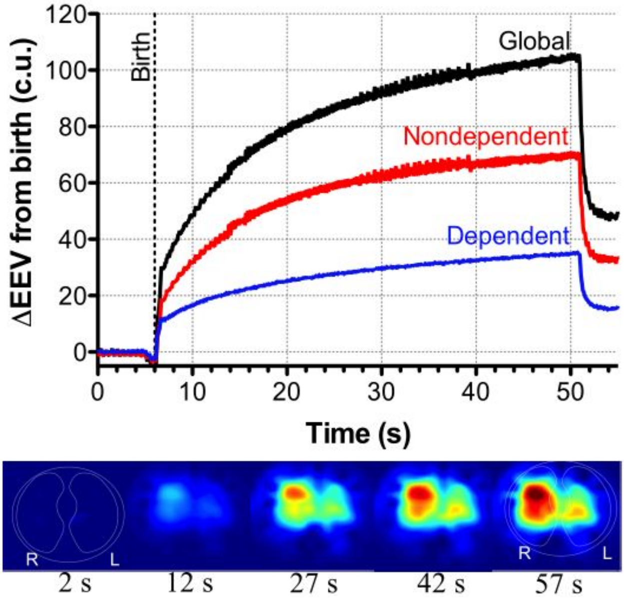


Blood Pressure via Pulse Transit Time



Source: Sola *et al, Med. Biol. Eng. Comput.*, 2011

First breath of life

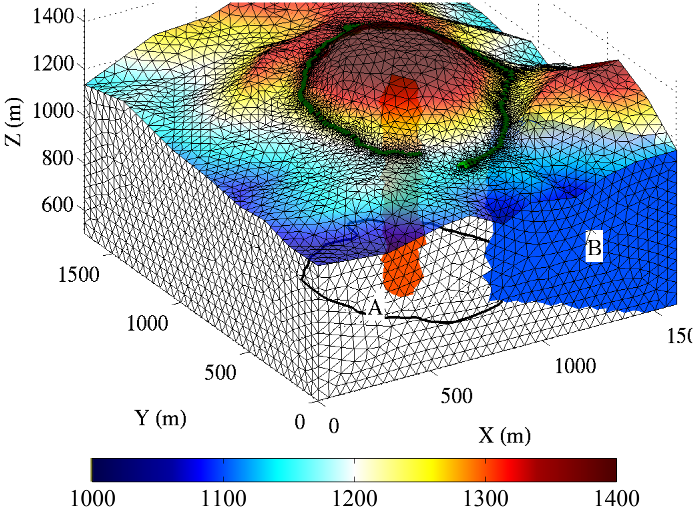


Source: D. Tingay *et al*, 2016

La Soufrière de Guadaloupe

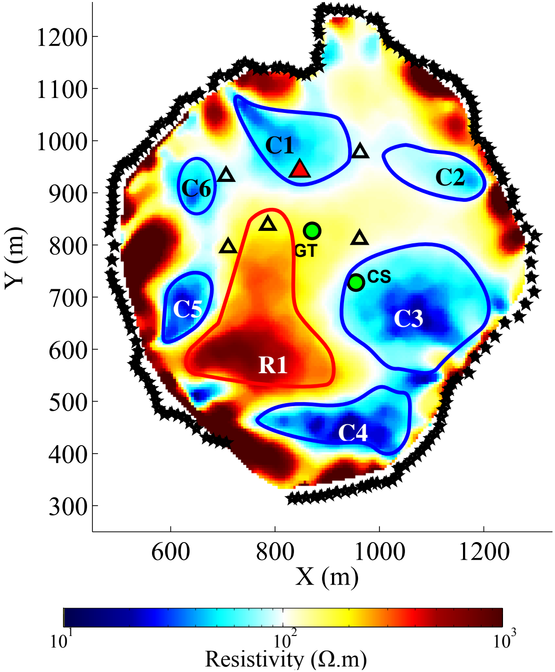
Figure 1. La Soufrière lava dome seen from North-East. The dashed line marks the Eastern segment of the electrode line shown in Fig. 2. The small

La Soufrière de Guadaloupe

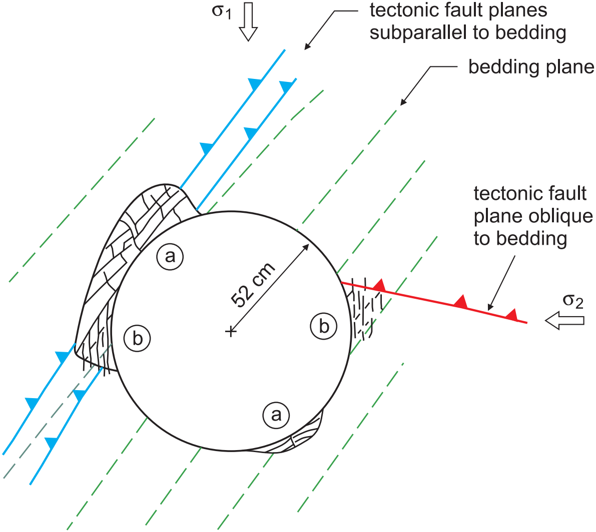


Source: N. Lesparre *et al*, *Geophys J Int*, 2014

La Soufrière de Guadaloupe



Excavation tunnels for Evaluation of Nuclear Waste Storage



Lesparre *et al*, Geophys J Int, 195:972–984, 2013

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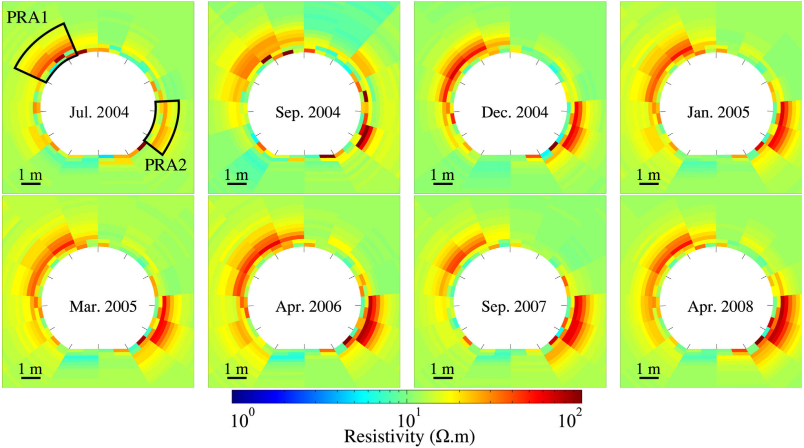

Thank you

Ingenious Talk: “Imaging with Electricity"

Wednesday, November 2, 2016
Speaker: Andy Adler

Summary: Technologies which see inside bodies from the outside (using X-rays, ultrasound, MRI) have revolutionized medicine and many other industries. One of the earliest ideas was to create these images with applied electrical currents. Recently improved computer algorithms have created new possibilities for electrical impedance imaging. In this talk, we will look at the kinds of images one can make with this technology, from measuring heart pressure to fluid flows inside active volcanoes.