# Evaluation of Reconstructed Images of Regional Lung Changes Using a Model

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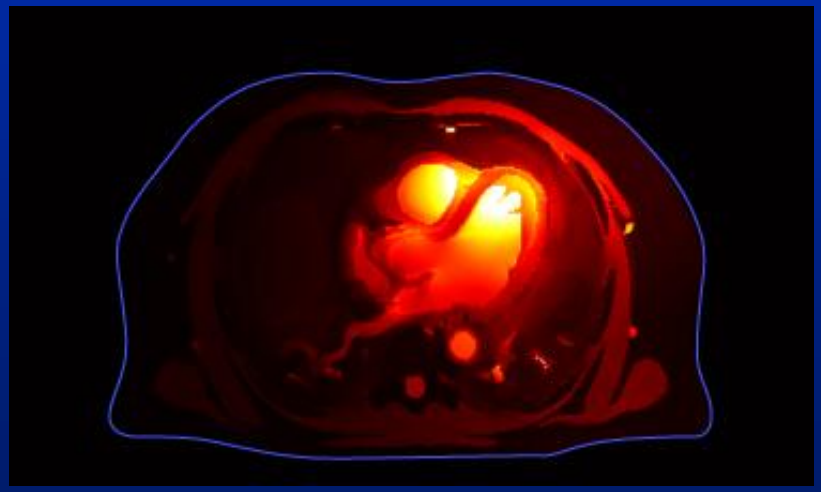


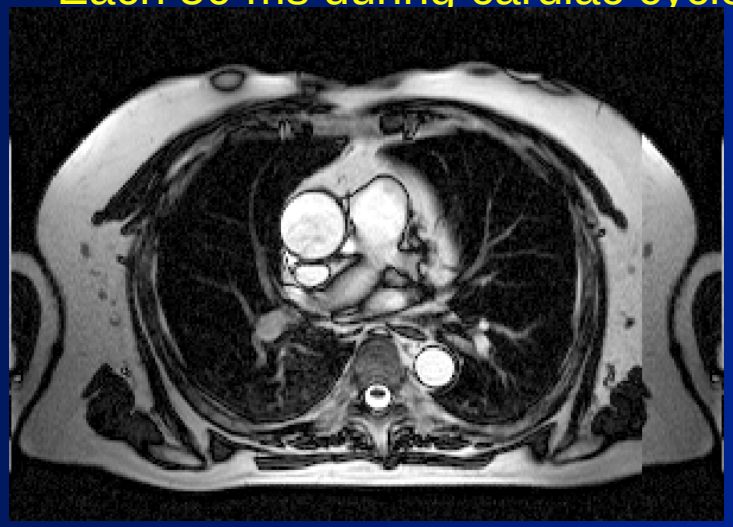
## *Question?*

How do regional changes in lung resistivity appear in images using a model for the forward data?

# Model Used

# ECG gated MRI image

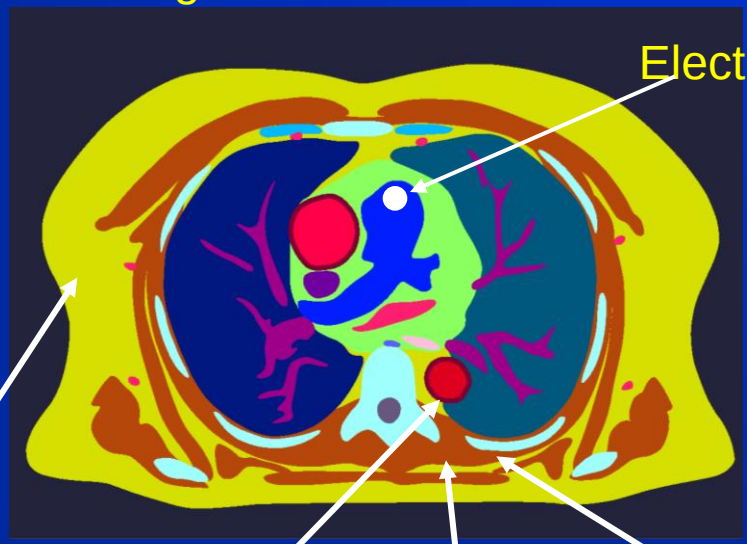
Each 50 ms during cardiac cycle



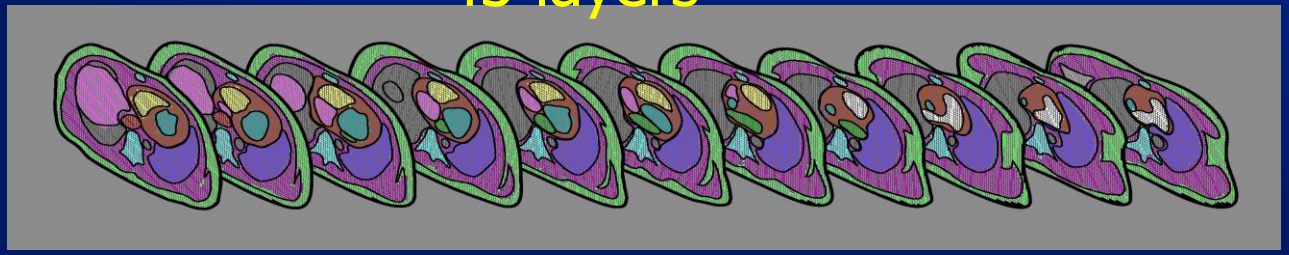
5 mm slices

# Segmentation

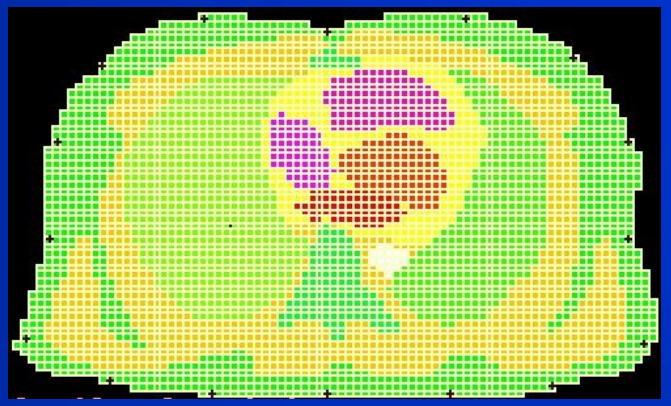
Using Abode Illustrator



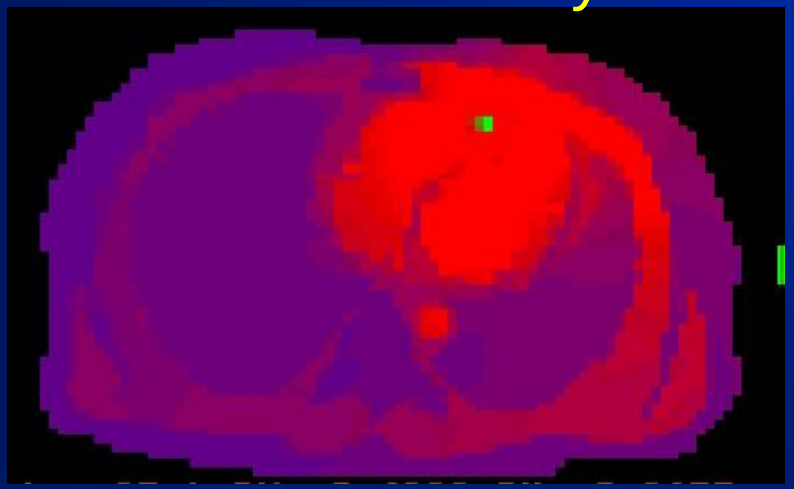

# 43 layers



# *Low or high resolution meshing?*



Low resolution
Current Density



216 000 elements
10 x 3.7 x 4.2 mm

High resolution
Current Density

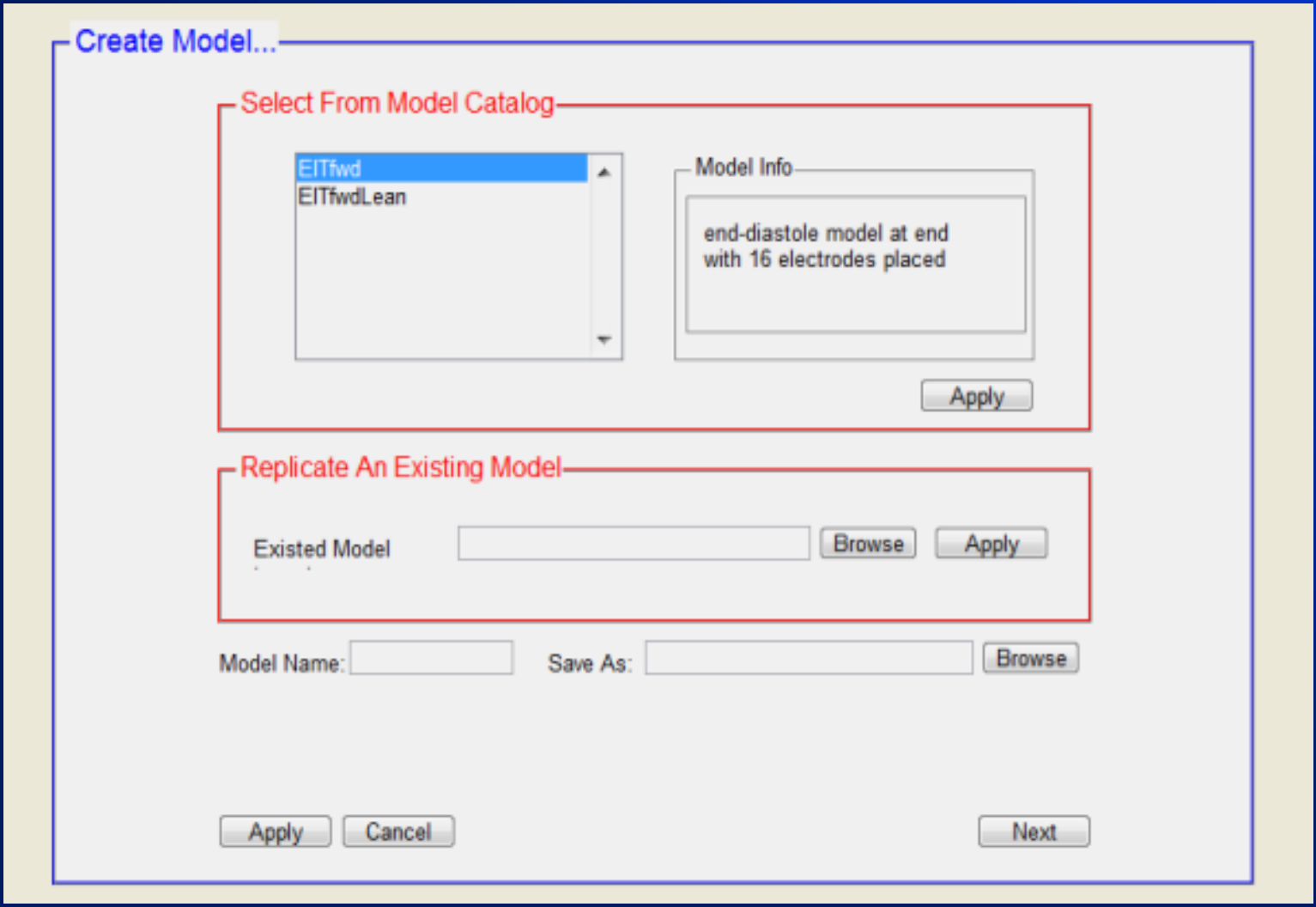
3.8 million elements
5 x 1.5 x 1.5 mm

# *A Friendly GUI for Model Creation and Analysis*

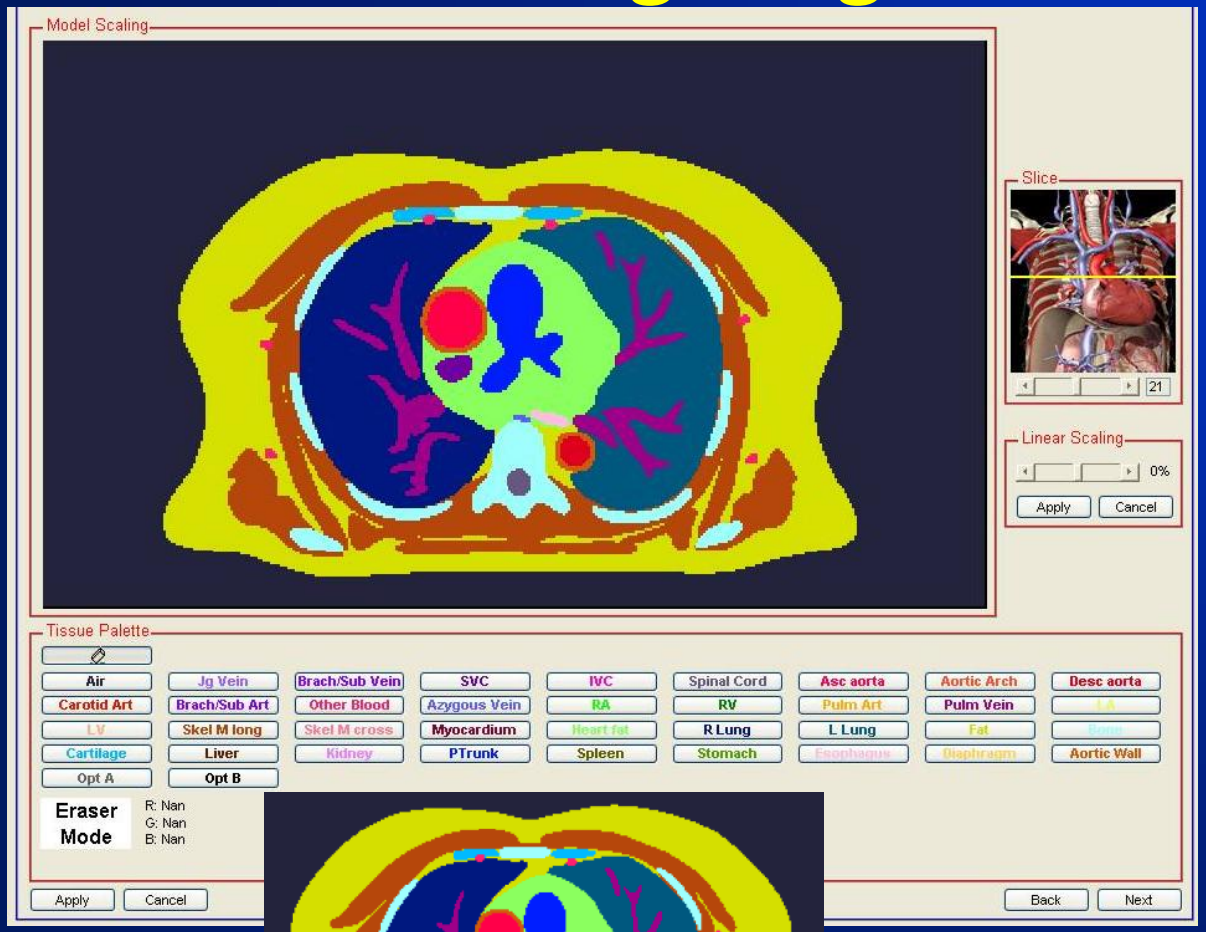
MIND EIT Forward Solver (MEFS) is a MATLAB based graphic user interface software package that provides a forward solution for the Sheffield electrode arrangement

# *MIND EIT Forward Solver (MEFS)*

## Choose a model



# Modified Lung Regions




Modified two posterior lung regions

Level 10

Level 16

Level 27

Level 33

# *Modify Tissue Resistivity?*

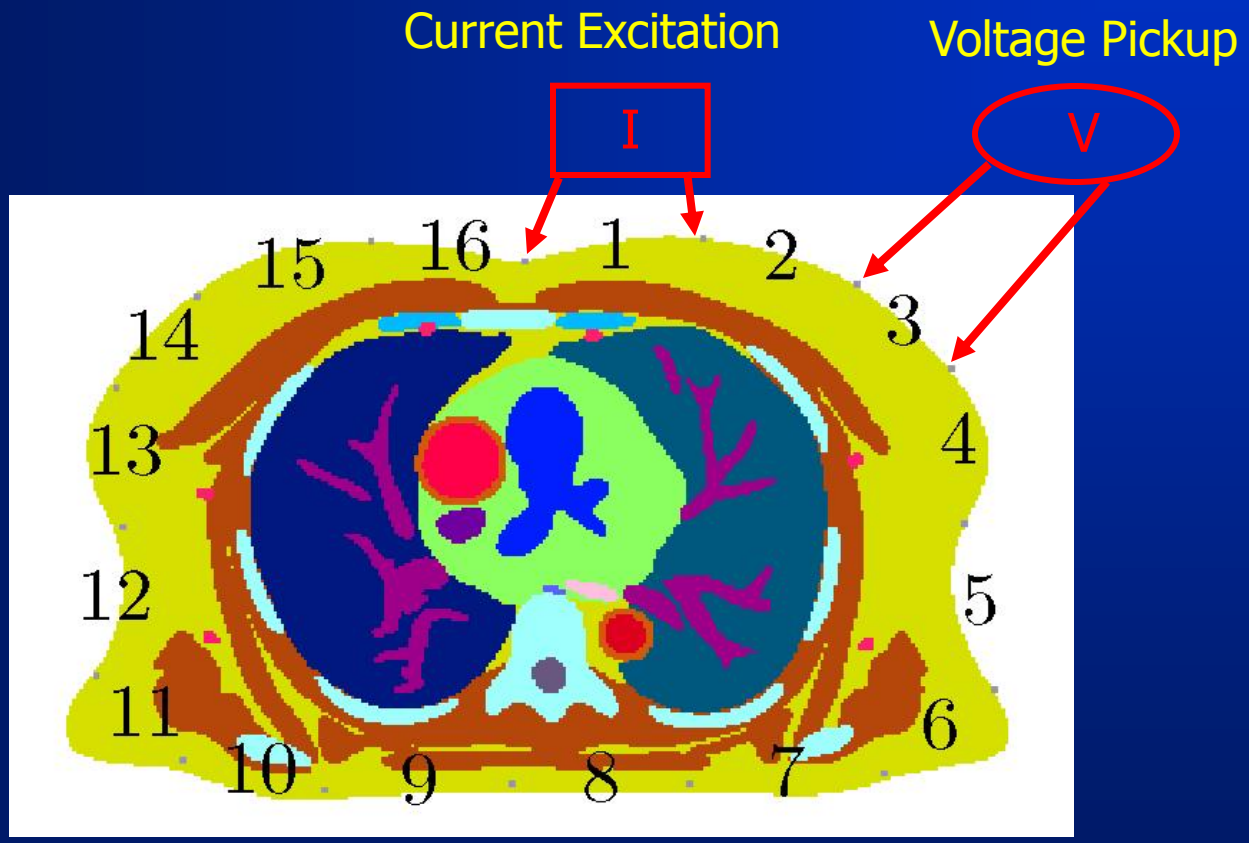
Resistivity Setting (ohm-cm)

| Tissue | Rho(x) | Rho(y) | Rho(z) | Label |
|---|---|---|---|---|
| pulmonary vein | 168 | 168 | 168 | 16 |
| left atrium | 150 | 150 | 150 | 17 |
| left ventricle | 150 | 150 | 150 | 18 |
| skeletal muscle long axis | 225 | 225 | 225 | 19 |
| skeletal muscle across sectional | 400 | 400 | 400 | 20 |
| heart muscle | 250 | 250 | 250 | 21 |
| HEART FAT | 2000 | 2000 | 2000 | 22 |
| right lung | 1400 | 1400 | 1400 | 23 |
| left lung | 1400 | 1400 | 1400 | 24 |
| fat | 2000 | 2000 | 2000 | 25 |
| bone | 2000 | 2000 | 2000 | 26 |
| cartilage | 2000 | 2000 | 2000 | 27 |

Resistivity Setting (ohm-cm)

| Tissue | Rho(x) | Rho(y) | Rho(z) | Label |
|---|---|---|---|---|
| bone | 2000 | 2000 | 2000 | 26 |
| cartilage | 2000 | 2000 | 2000 | 27 |
| liver | 600 | 600 | 600 | 28 |
| kidney | 600 | 600 | 600 | 29 |
| pulmonary trunk | 150 | 150 | 150 | 30 |
| spleen | 150 | 150 | 150 | 31 |
| stomach | 400 | 400 | 400 | 32 |
| esophagus | 400 | 400 | 400 | 33 |
| diaphragm | 400 | 400 | 400 | 34 |
| aortic wall | 250 | 250 | 250 | 35 |
| option a | 1000 | 1000 | 1000 | 36 |
| option b | 2200 | 2200 | 2200 | 37 |

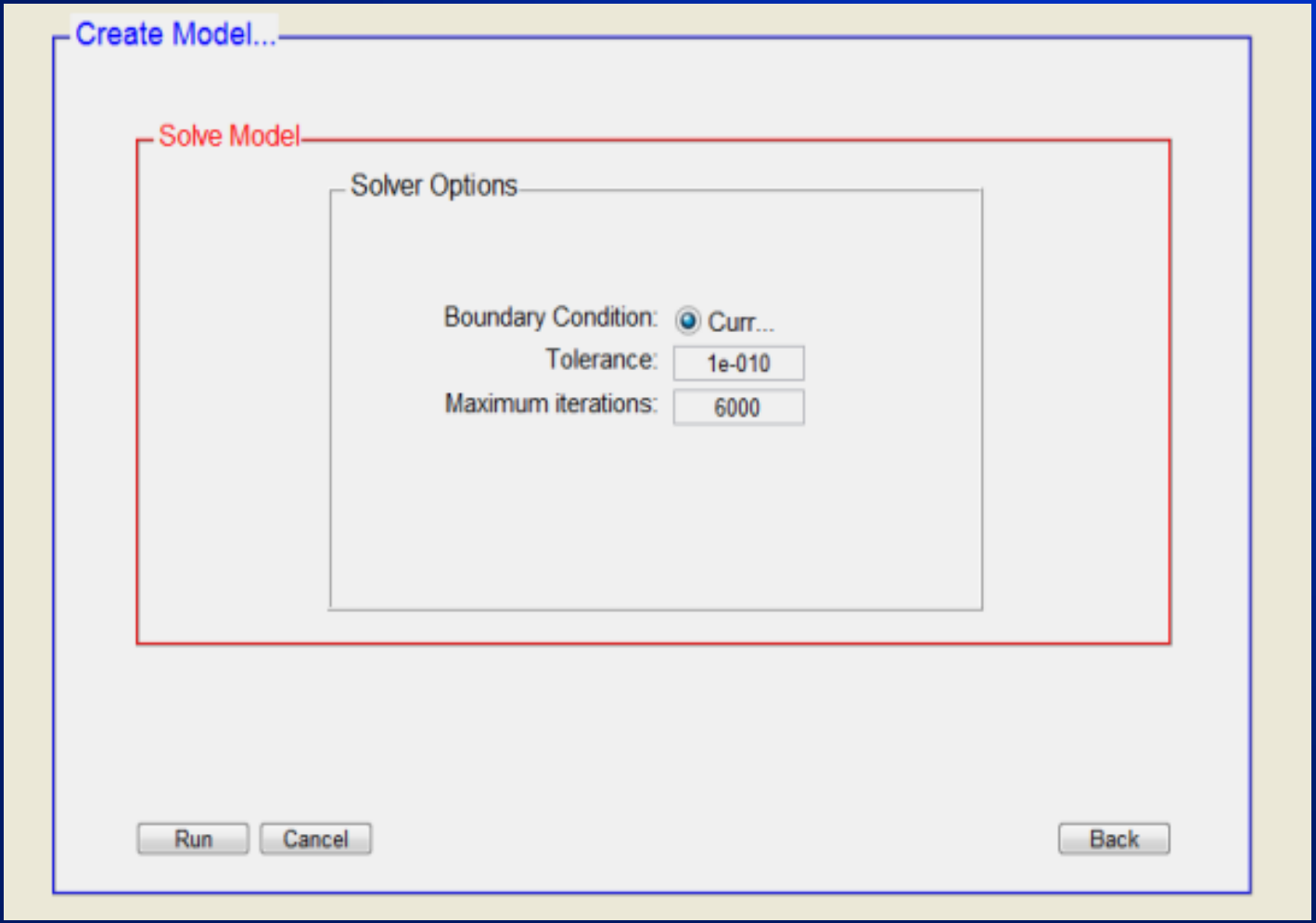
# *16 Electrodes at Mid-Thorax*



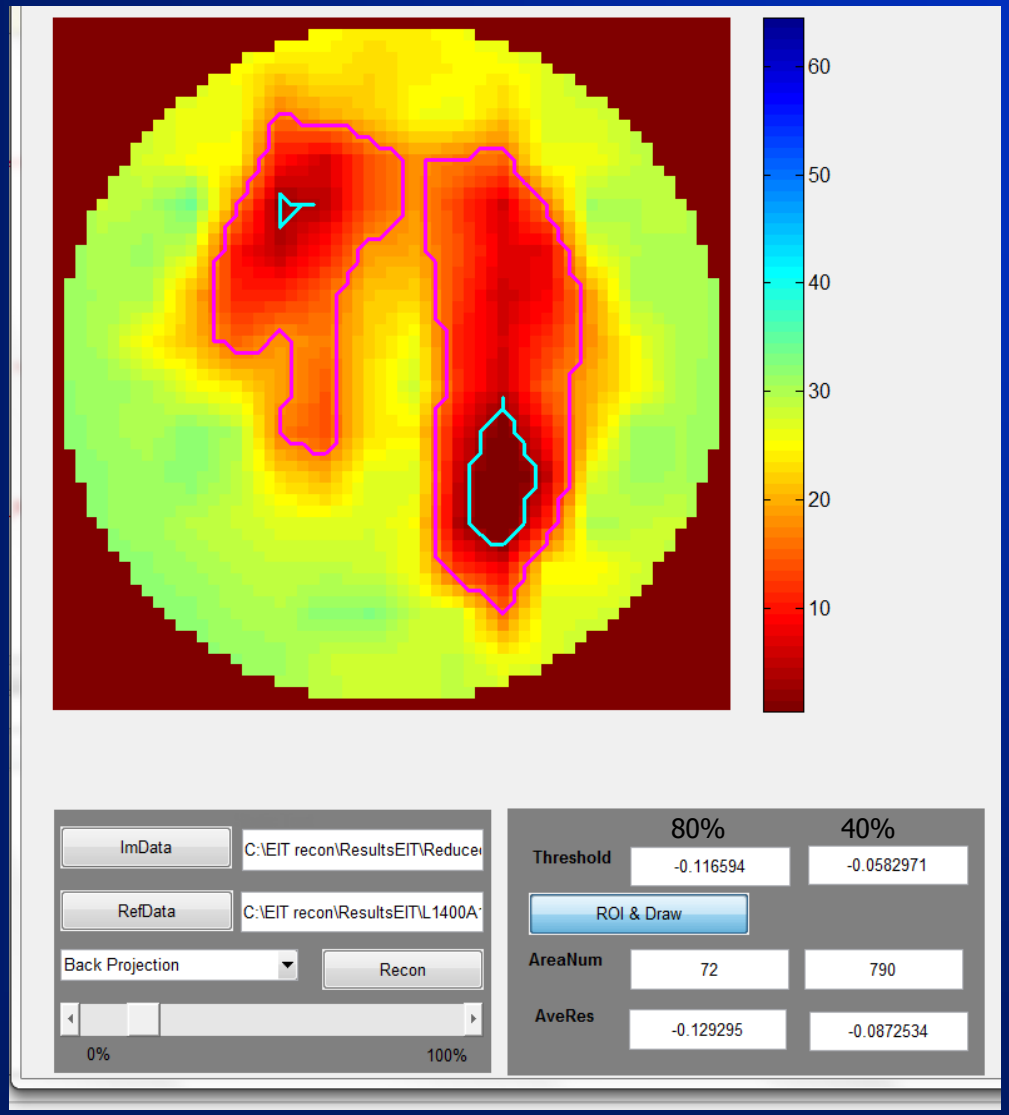

The model was solved 16 times for each unique current excitation

# *MIND EIT Forward Solver (MEFS)*

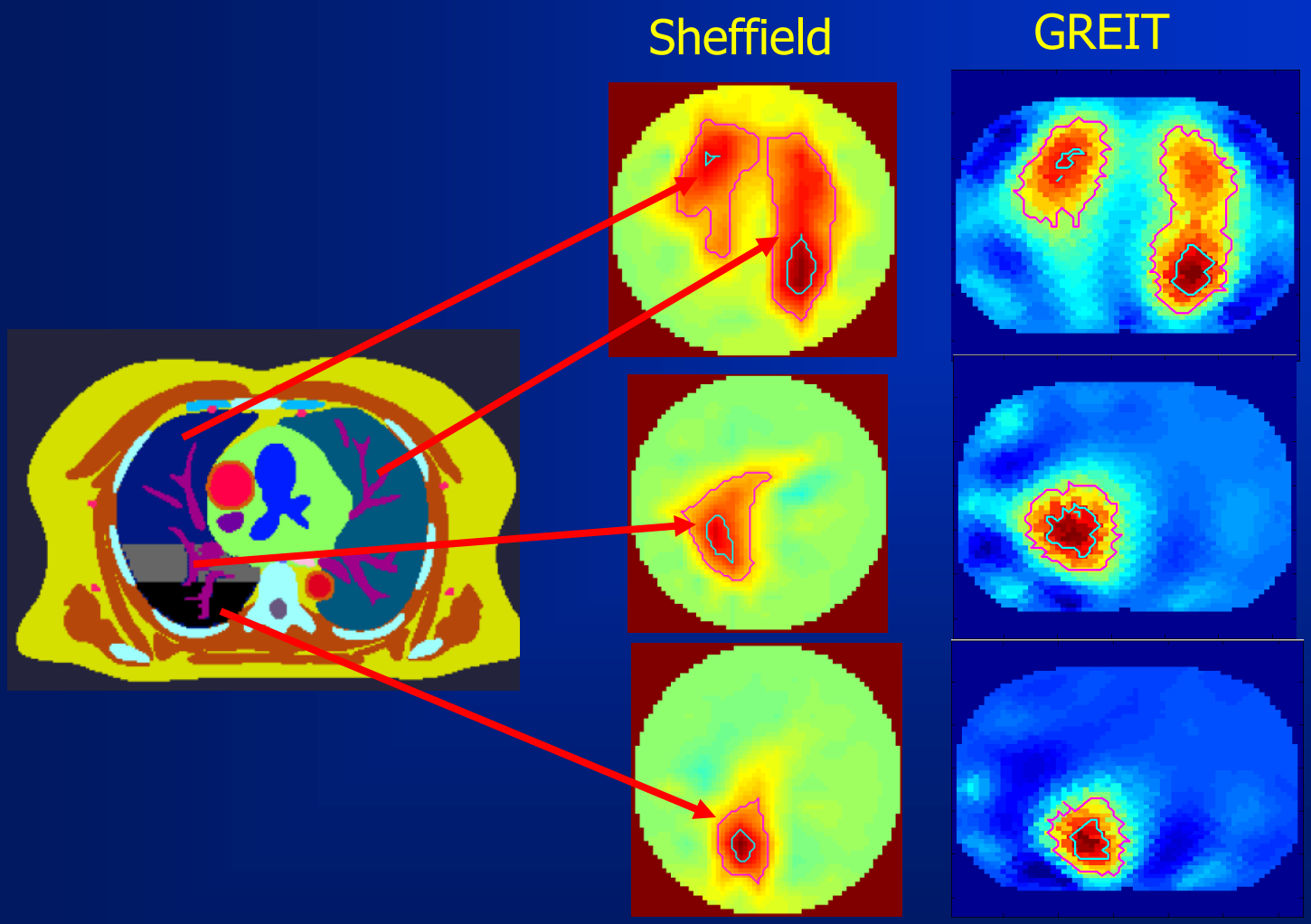
## RUN



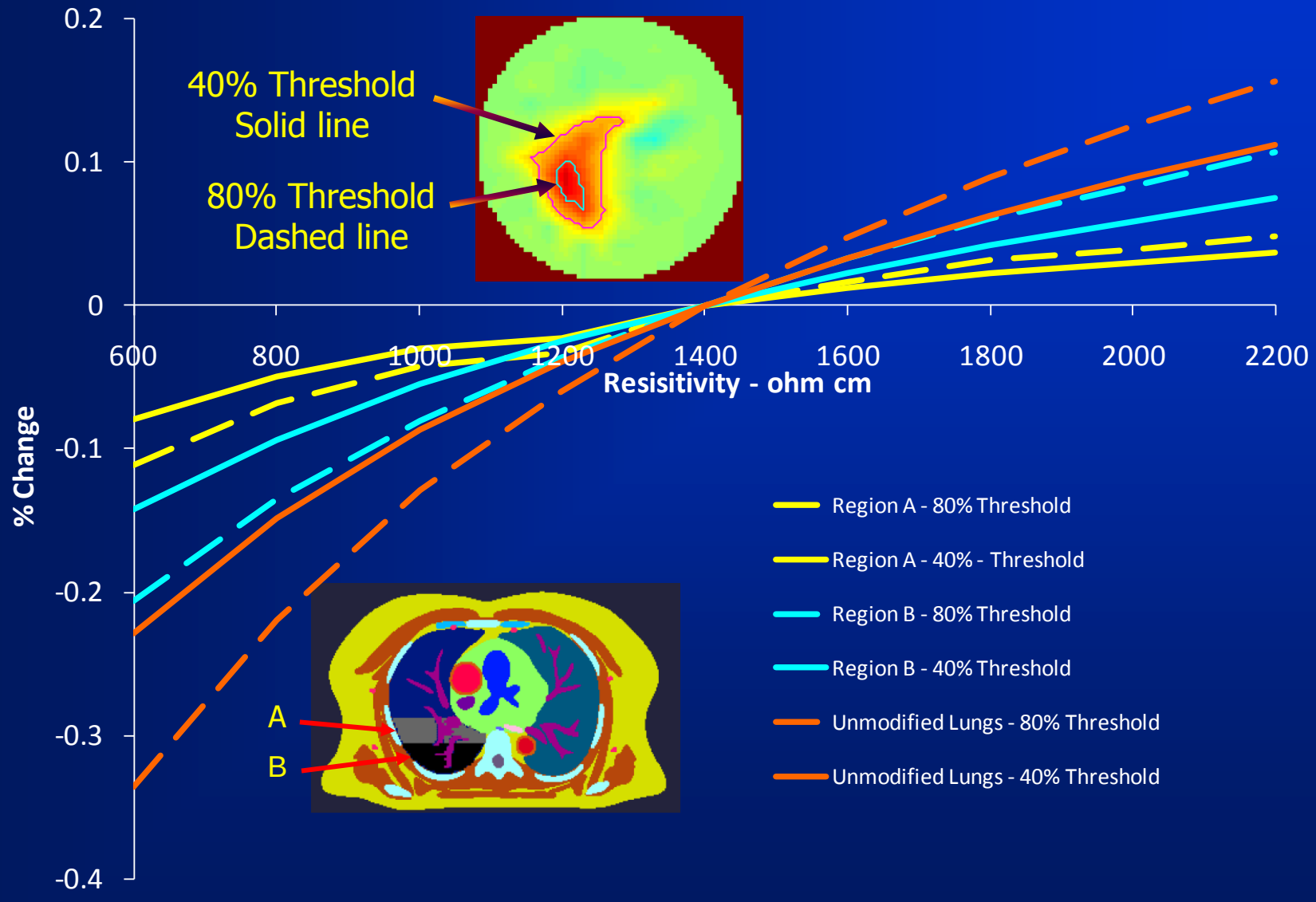
# Analysis Screen



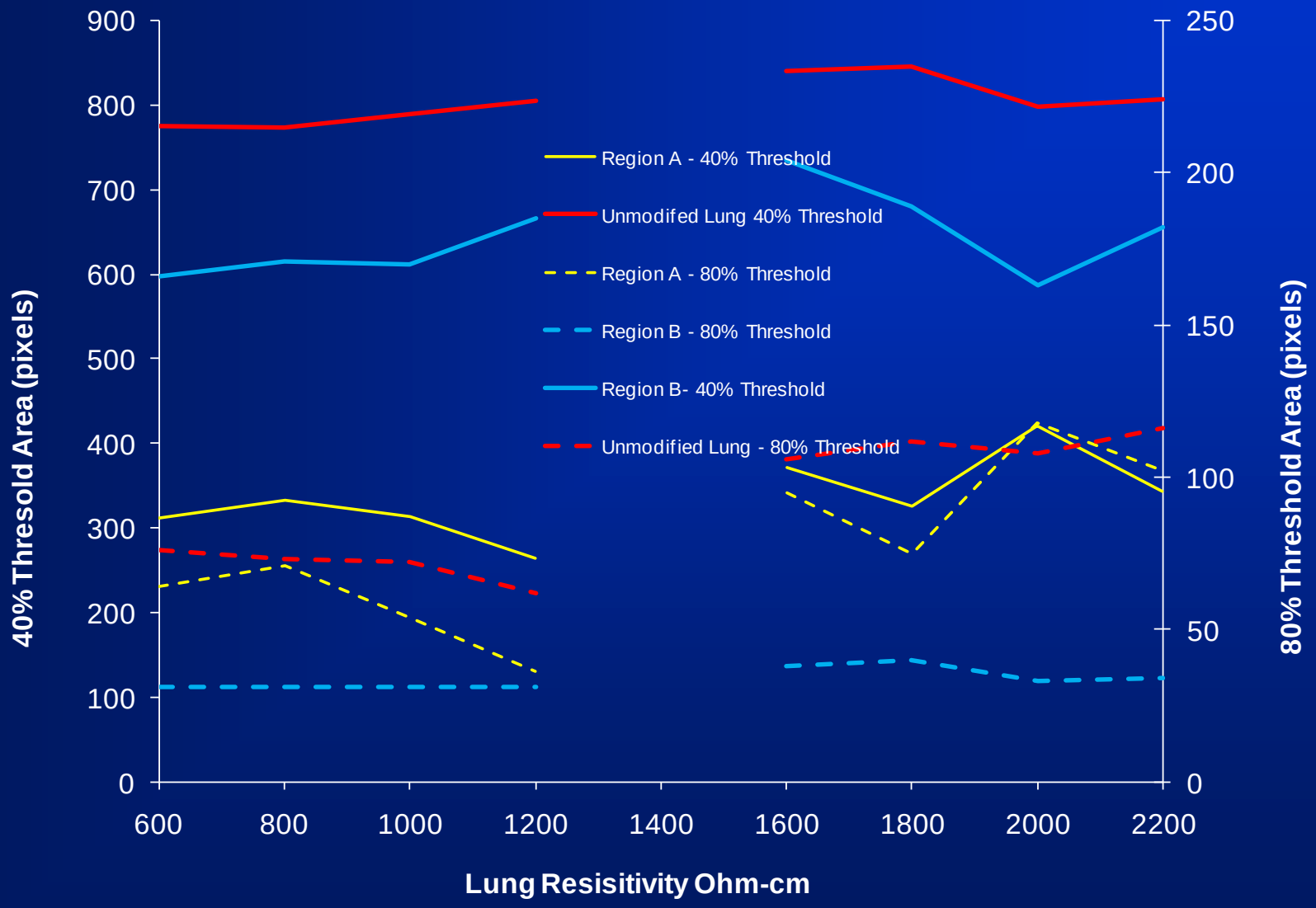
*Example with each lung area changed to 1000 ohm-cm*



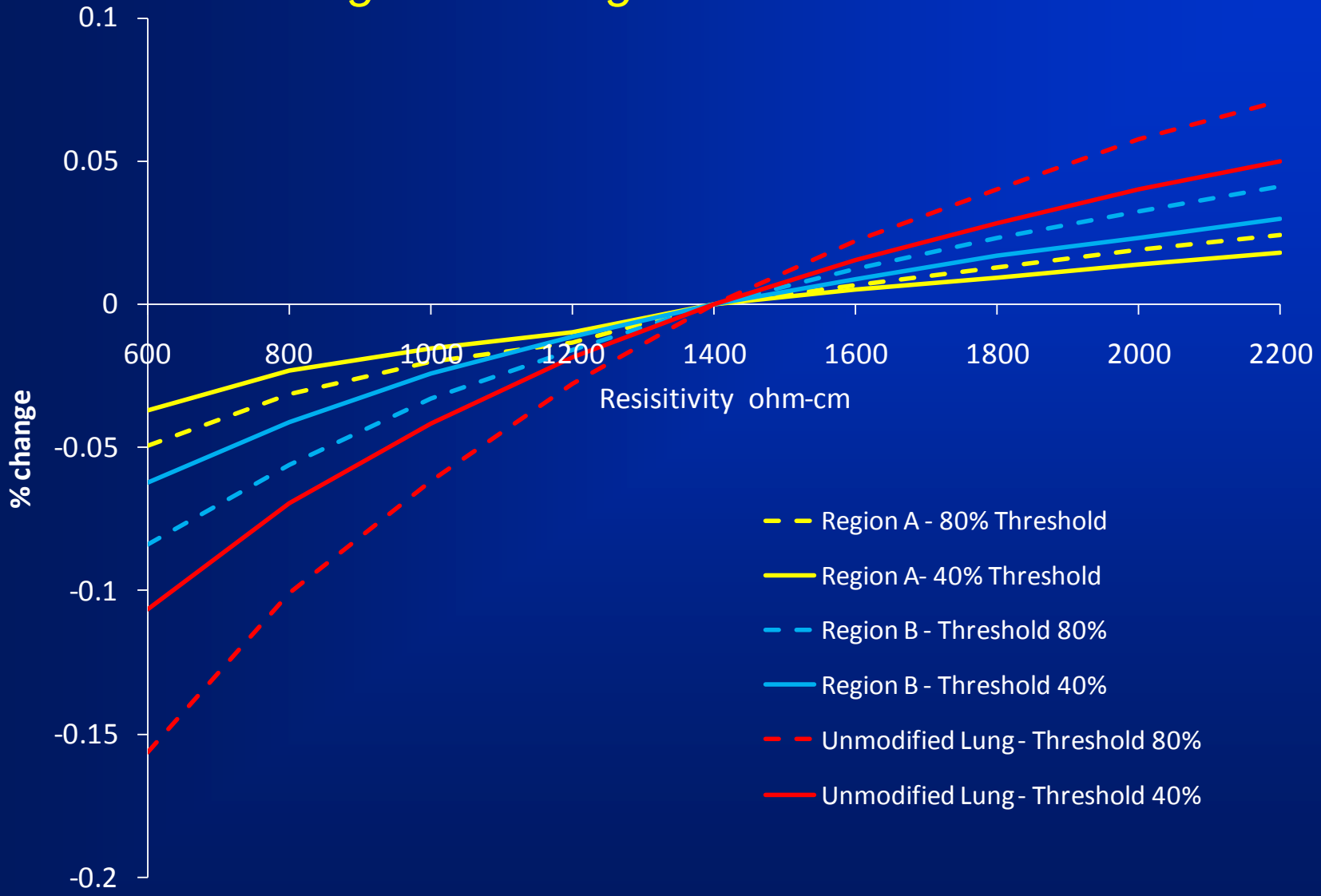
# *Results from Changing Lung Resistivity from 600 to 2200 ohm-cm using Sheffield Algorithm*



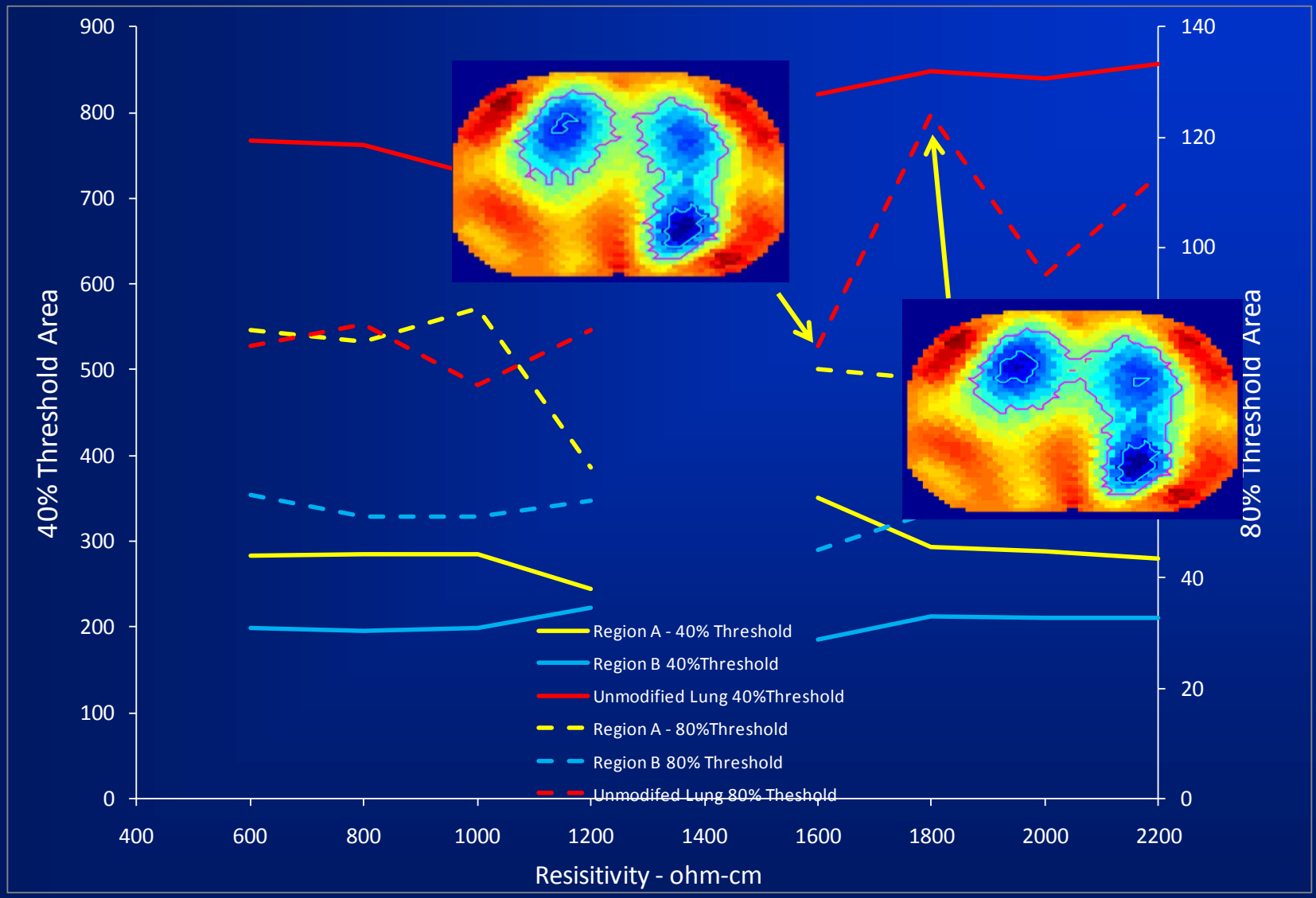
# Area change using the Sheffield Algorithm as a % of Max for Condition



# *Results from Changing Resistivity from 600 to 2200 ohm-cm using GREIT Algorithm*



# Area change using the GREIT Algorithm as a % of Max for Condition



# *Conclusion*

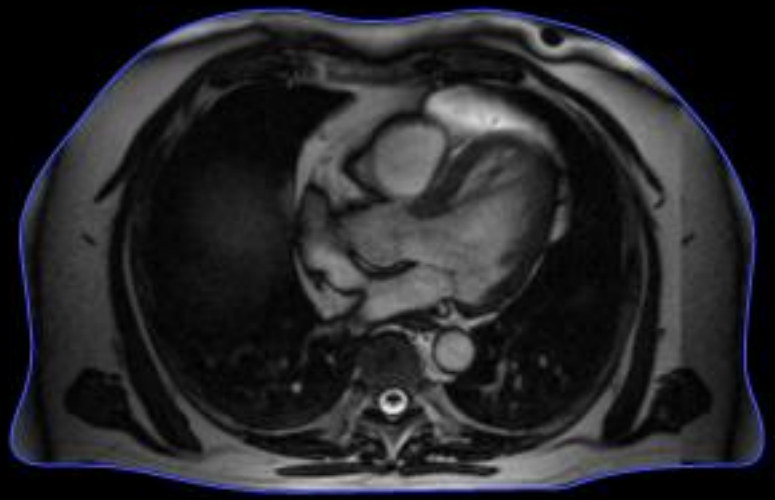
MEFS offers a software package that is easily to used, which can quantitatively evaluate various EIT reconstruction algorithms

# Thanks for Listening

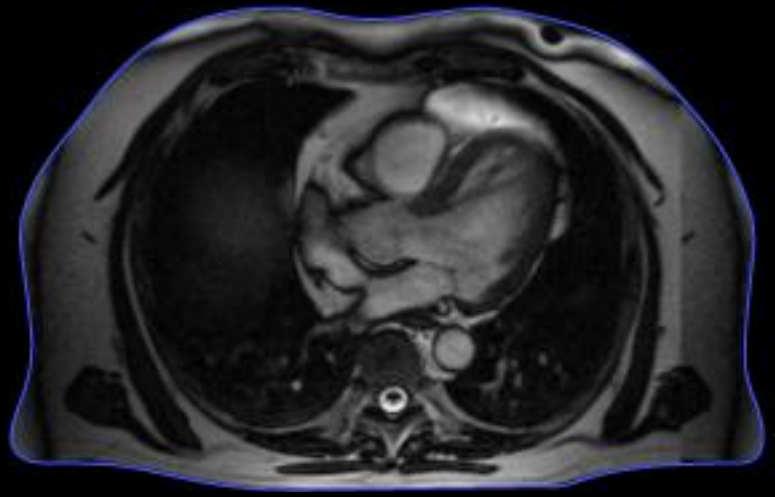
The Oshkosh WI, Airport from the International Space Station

# *Comparison of electrode locations: sensitivity*

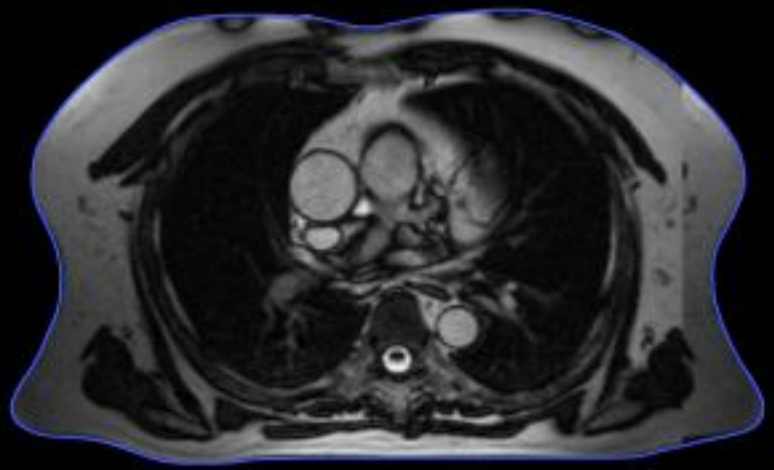
**RV**



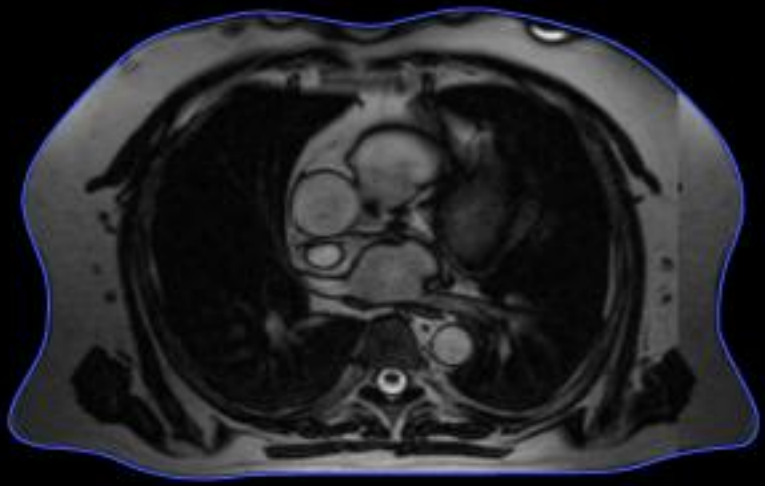
**RV coil**



localizer



**RA**



**LVCV**

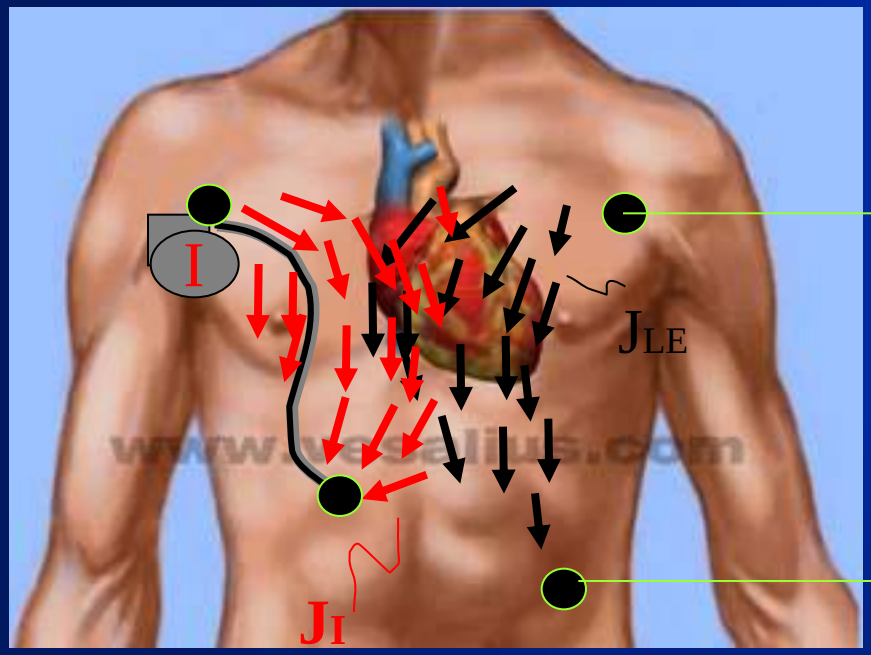
# Lead Field Theory

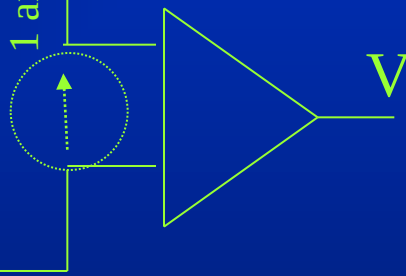
JI may be obtained in a computer model

JI: lead field of injected current

JLE: lead field of pickup electrodes

JLE may be obtained by reciprocity in a computer model.




$$Zt = \frac{V}{I}$$

Otto Schmitt first to propose:

$$Z = \int \rho \, J_{LE} \cdot J_I \, dv$$

Sensitivity distribution

Then mathematically proven by Geselowitz in 1971.

# Sensitivity Analysis

$$Z = \int \rho \, J_{LE} \bullet J_I \, dv$$

Matlab

| | | |
|---|---|---|
| air | 0.00000000 ohms | 0.00 % |
| Jugular vein | 0.02236529 ohms | 0.03 % |
| brachiocephalic, subclavian vein | 0.30973676 ohms | 0.44 % |
| sup. vena cava | 0.01750516 ohms | 0.02 % |
| inf. vena cava | 0.00440736 ohms | 0.01 % |
| spinal cord | 0.02196743 ohms | 0.03 % |
| ascending aorta | 0.04345968 ohms | 0.06 % |
| aortic arch | 0.11498361 ohms | 0.16 % |
| descending aorta | 0.06885995 ohms | 0.10 % |
| carotid arteries | 0.00000000 ohms | 0.00 % |
| brachiocephalic, subclavian arteries | 0.19739194 ohms | 0.28 % |
| other arterial blood | 0.17940933 ohms | 0.25 % |
| azygous vein | 0.00527963 ohms | 0.01 % |
| right atrium | 0.03346155 ohms | 0.05 % |
| right ventricle | 0.11870241 ohms | 0.17 % |
| pulmonary artery | 0.00000000 ohms | 0.00 % |
| pulmonary vein | 0.93691461 ohms | 1.33 % |
| left atrium | 0.23355130 ohms | 0.33 % |
| left ventricle | 3.77208881 ohms | 5.36 % |
| skeletal muscle long axis | 20.13149520 ohms | 28.59 % |
| skeletal muscle across sectional | 0.00000000 ohms | 0.00 % |
| heart muscle | 8.41862416 ohms | 11.96 % |
| HEART FAT | 4.00992003 ohms | 5.69 % |
| right lung | 0.09421865 ohms | 0.13 % |
| left lung | 13.83721035 ohms | 19.65 % |
| fat | 15.87351760 ohms | 22.54 % |
| bone | 1.41879010 ohms | 2.01 % |
| cartilage | 0.04330071 ohms | 0.06 % |
| liver | 0.03599823 ohms | 0.05 % |
| kidney | 0.00000000 ohms | 0.00 % |
| pulmonary trunk | 0.20376950 ohms | 0.29 % |
| spleen | 0.01136754 ohms | 0.02 % |
| stomach | 0.01261023 ohms | 0.02 % |
| esophagus | 0.03332739 ohms | 0.05 % |
| diaphragm | 0.20868111 ohms | 0.30 % |

GRAND TOTAL Z: 70.41 ohms.