

## Mathematician Develops Solutions for Heart and Lung Patients

Each day at the Electrical Impedance Tomography Laboratory in the Department of Mechanical Engineering at the University of São Paulo (USP), Brazil, physicians and engineers, graduates and undergraduates are working together to advance a technique for heart and lung imaging from electric fields. In spring 2007, USP was also the sabbatical home to CSU mathematics professor Jennifer Mueller.



Electrical impedance tomography (EIT) is a relatively new imaging technique in which electrodes are placed on the surface of the body, a low-amplitude current

is applied on the electrodes, and the resulting voltages are measured. An inverse problem is solved to determine the conductivity distribution in the body, and the results are plotted to form an image. The resolution of the image is very poor compared to that of an MRI or CT scan. However, the usefulness of EIT in heart and lung imaging is that “while other technologies are focused on and therefore represent anatomy, EIS serves as a visualization of regional organ function and has very good resolution in time,” says Stephan Böhm, a member of the research team in São Paulo.

Patients with ARDS (acute respiratory distress syndrome) have collapsed alveoli, or airways, in the lungs. The treatment for this condition is mechanical ventilation, which reinflates the airways (recruitment) over time. Eventually, the patient recovers and can be weaned from the ventilator. However, alveolar collapse, cyclic closing and reopening of the airways, and lung overdistention are dangerous side effects of mechanical ventilation that can be prevented by choosing the proper settings for the ventilator.

Physician Marcelo Amato founded the research team in 1997 when he became convinced that EIT technology would provide the best solution for the problem of monitoring patients undergoing mechanical ventilation. The protective ventilation technique employs a low inspiratory driving pressure, which should result in slower recruitment, and high end-expiratory pressure to avoid reclosing of alveoli. These settings are currently determined from the pressure-volume (PV) curve. Prior to EIT, a method did not exist for determining regional ventilation data or monitoring for ventilator-induced problems such as cyclic lung collapse or over-inflation. Methods used to monitor patients undergoing mechanical ventilation include monitoring blood gases and pressure-volume curves, but these quantities do not provide regional information about lung aeration. EIT can also effectively diagnose lung pathologies such as pulmonary embolus, pulmonary edema and pneumothorax.

Mueller has been working in EIT for the past 10 years. She is co-advising the Ph.D. theses of two USP students in EIT who plan to spend the 2008-2009 academic year in residence at CSU.

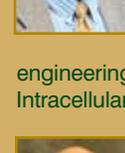
Dr. Raul Gonzalez-Lima and Dr. Julio Aya in the electrical impedance imaging lab at USP.

### Faculty: Medical Diagnostics, Devices, and Imaging

Chuck Anderson, associate professor, computer science; *Research interest:* Biomedical image and signal processing



V. Chandrasekar, professor, electrical and computer engineering; *Research interest:* Bio signal processing



Tom Chen, professor, electrical and computer engineering; *Research interest:* Intracellular communicative sensor development



Kevin Lear, associate professor, electrical and computer engineering; *Research interest:* photonic biosensors



Jennifer Mueller, associate professor, mathematics; *Research interest:* mathematical biology and imaging



Brad Reisfeld, assistant professor, chemical and biological engineering. *Research interest:* Metabolomics, computation toxicology, systems biology

### Other faculty working in this area:

Jim Bamburg  
Norman Curthoys  
David Dandy  
William Dernel  
Frank Dinunno  
Charles Henry  
Susan P. James  
Stuart Tobet  
Ranil Wickramasinghe

