# Non-invasive fusion imaging for regional evaluation of obstructive lung disease using MRI and PET

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20 million people, and COPD was the fourth leading cause of death in the USA with 119,000 lives lost according to 2002 American Lung Association statistics. Lung transplant techniques continue to improve with over 1000 lung transplants performed in 2003. However, the long term success of these transplants will require monitoring to detect chronic rejection. Recent studies show that obstructive lung diseases have complex regional physiology not captured by traditional pulmonary function measures, thus making these diseases ideal targets for evaluation with noninvasive imaging methods. CT, MRI, and PET have demonstrated the potential for determining regional physiology of lung diseases in humans but challenges including a need for improved temporal and spatial resolution and validation in disease remain.

The hypothesis of this work is that non-invasive *in vivo* imaging using H-1 and hyperpolarized He-3 MRI and [F-18]FDG PET can measure and quantify regional changes associated with obstructive lung diseases, particularly asthma and lung transplant rejection, for longitudinal and single-time-point experiments. We have also developed multi-modality fusion imaging methods for the regional study of lung inflammation, ventilation, glucose metabolism, and cellular activation in small animals.

Results will be shown representing the first fusion imaging of the key physical components of these diseases *in vivo*. The methods are developed in rat models of asthma and lung transplant, and are capable of providing *in vivo* imaging for longitudinal studies confirmed with lung physiology and in terminal studies with histological evaluation. Several of these imaging techniques have been extended for application in human patients and volunteers. A composite 2D-3D-2D acquisition is demonstrated for measuring respiratory dynamics of regional ventilation. This technique uses a single breath of hyperpolarized gas during which dynamic images are acquired depicting the inspiration and forced expiration separated by a short breath-hold. Imaging results are confirmed with CT and body plethysmography. Multi-echo 3D PR methods have been developed to provide isotropic spatial resolution for improved detection of ventilation abnormalities. Numerical simulations were performed to optimize the PR trajectory and results have been confirmed in healthy volunteer studies.