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## **A Fuller Picture of Your Lungs**

A cheap MRI machine images lung function more realistically.

By Katherine Bourzac

Magnetic resonance imaging (MRI) can create detailed images of almost all the tissues of the body, allowing doctors to monitor blood flow in the brain, map the borders of tumors, and find slipped spinal discs. But conventional MRI, which images water in the body, produces poor pictures of the lungs, which are full of air, and gives an incomplete picture of lung functions. Now researchers at the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA, have built a cheap MRI machine that uses a weak magnetic field to image critical aspects of lung physiology that are invisible to conventional imaging techniques.

Led by [Matthew Rosen \(http://cfa-www.harvard.edu/Walworth/Group/Matt.html\)](http://cfa-www.harvard.edu/Walworth/Group/Matt.html), a visiting scientist at the Harvard-Smithsonian center, and [Ronald Walworth \(http://cfa-www.harvard.edu/Walworth/Group/Ron/Ron.html\)](http://cfa-www.harvard.edu/Walworth/Group/Ron/Ron.html), a senior lecturer in physics at Harvard, the researchers built an MRI scanner that images how gas flows through the lungs and how much oxygen is being absorbed throughout lung tissue. They've used the system to study how lung function differs when lying down and sitting or standing up, and are planning a study of asthma in conjunction with the [Martinos Center for Biomedical Imaging \(http://www.nmr.mgh.harvard.edu/martinos/\)](http://www.nmr.mgh.harvard.edu/martinos/) in Boston. The system has not yet been used to compare healthy and diseased patients. If it proves its worth in clinical trials, the Harvard researchers believe it would be inexpensive and simple enough to be used in pulmonologists' offices.

Lung function is dependent on the orientation of the body, but it hasn't been possible to study this before because conventional MRI would require patients to lie on their backs. (PET can be used to look at some aspects of the physiology of the lungs but it gives limited information.) Asthma symptoms can be exacerbated when patients lie down, for example. The Harvard system "allows imaging with the patient in any orientation, something no one has ever been able to do," says [Bastiaan Driehuys \(http://www.civm.duhs.duke.edu/staffdetails.htm#Anchor-Bastiaan-35326\)](http://www.civm.duhs.duke.edu/staffdetails.htm#Anchor-Bastiaan-35326), an assistant

professor at the Center for In Vivo Microscopy at Duke University.

The open MRI system may also make it possible to monitor the lung function of newborns in intensive care without taking them out of their incubators. The researchers have filed a provisional patent for this application.

Unlike conventional MRI, which images the protons in water molecules, the Harvard MRI system monitors magnetically polarized helium gas inhaled by subjects. Conventional MRI requires a magnet about 150 times stronger than that in the Harvard system to magnetically align protons inside the body. But the helium used in the Harvard system is magnetically aligned before the patient inhales it, making it possible to use a very weak magnet inside the scanner.

In Rosen's imager, the magnetic field is generated by two coils mounted on what look like two metal garden trellises. Wire grids and rings in these structures direct the field towards a person lying, standing, or sitting up in the center. (In conventional MRI machines, a cylindrical magnet that surrounds the supine patient produces the strong magnetic field.) The subject wears an antenna over his or her chest that consists of a cardboard tube wrapped with a coil of wire and coated in rubber. After inhaling a mixture of polarized helium and air through a tube, the subject must sit still and hold his or her breath for up to 30 seconds while the antenna picks up the magnetic spin of the helium in the subject's lungs. Rosen says the system cost less than \$100,000 to build.

In their imager, Rosen and Walsworth can see the position of helium atoms in a subject's lungs. Oxygen molecules influence the spin of the polarized helium, so the Harvard system can also visualize the concentration of oxygen in the lungs. If it's high in one region of the lung, oxygen isn't being absorbed well and the subject may have poor lung function.

There are several other groups using polarized gas to create MRI images of the lungs, says Driehuys. But all the other groups use expensive, commercially available MRI systems. What makes Rosen and Walworth's work unique, Driehuys says, is that they've built their own cheap, low-power MRI scanner.

The Harvard-Smithsonian researchers are now adapting their system to shorten the time needed for imaging. "You do have to stay still and hold your breath," says Rosen, which can be difficult for people with compromised lung function.

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