

## Final Progress Report DOE DE-FG02-01ER63118

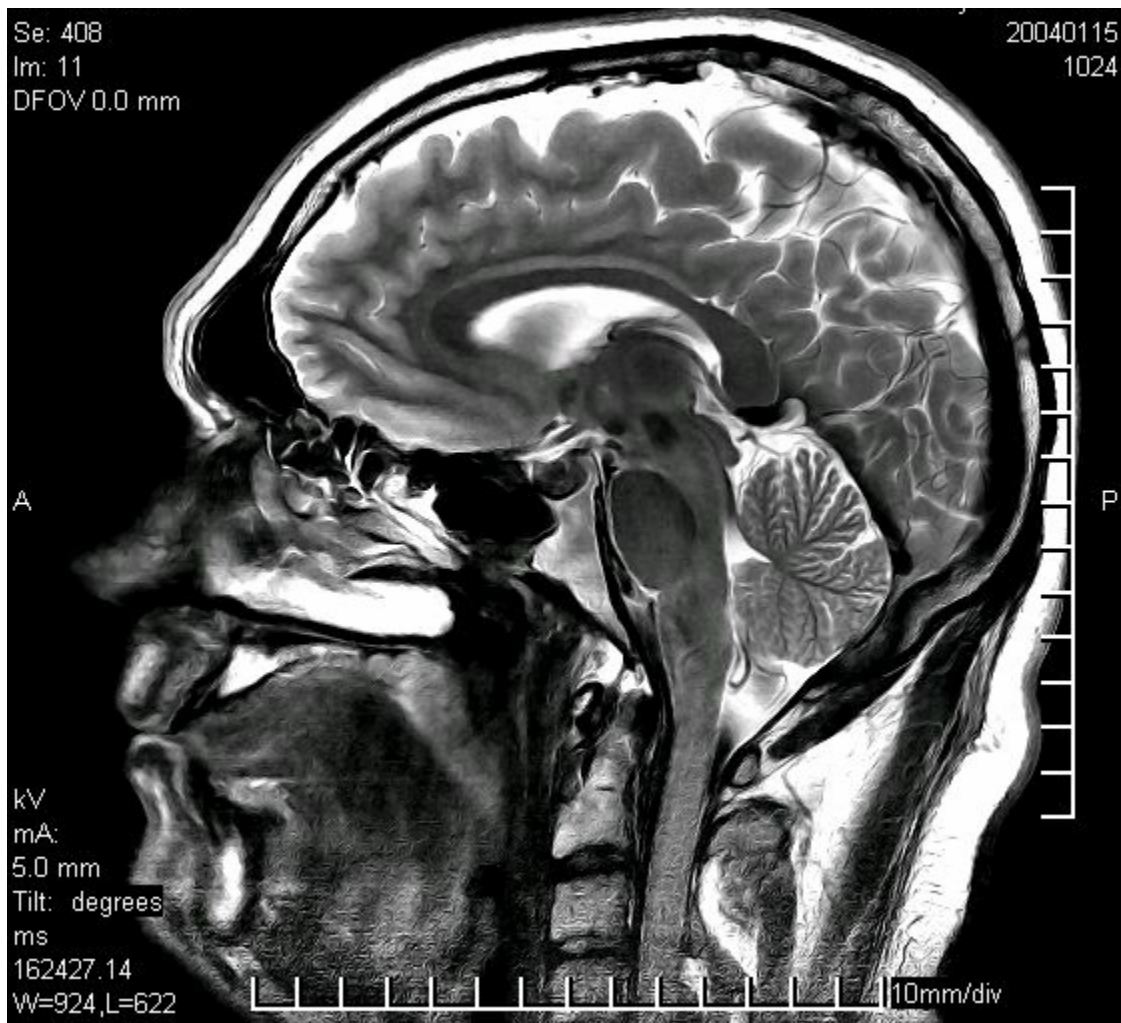
The objective of this proposal was twofold. First, upgrade existing MRI equipment, specifically a research 4.1T whole-body system. Second, purchase a clinical, state-of-the-art 3T MRI system tailored specifically to cardiovascular and neurological applications. This project was within the guidelines of *Medical Applications and Measurement Science*. The goals were: [1] to develop beneficial applications of magnetic resonance imaging; [2] discover new applications of MR strategies for medical research; and [2] apply them for clinical diagnosis. Much of this proposal searched for breakthroughs in this noninvasive and nondestructive imaging technology. Finally, this proposal's activities focused on research in the basic science of chemistry, biochemistry, physics, and engineering as applied to bioengineering. The centerpiece of this grant was our 4.1T ultra-high field whole-body nuclear magnetic resonance system and the newly acquired state-of-the-art, heart and head dedicated 3T clinical MRI system.

We have successfully upgraded the equipment for the 4.1T system so that it is now state-of-the-art with new gradient and radio frequency amplifiers. We also purchase a unique InVivo EKG monitoring unit that will permit tracking clinical quality EKG signals while the patient is in a high field MR scanner. Important upgrades of a peripheral vascular coil and a state-of-the-art clinical workstation for processing complex heart images were implemented. The most recent acquisition was the purchase of a state-of-the-art Philips 3T Intera clinical MRI system. This system is unique in that the magnet is only 5 ½ feet long compare to over 12 feet long magnet of our 4.1T MRI system. The 3T MRI system is fully functional and its use and applications are already greatly benefiting the UAB with 200-300 micron resolution brain images and diagnostic quality MR angiography of coronary arteries in less than 5 minutes.

Below are some images obtained from the UAB 3T MRI system, which is the first system in Alabama, and a picture of UAB's new 3T MR system.



Right Coronary Artery



UAB 3T MRI of a normal brain



UAB 3T MRI Suite

This state-of-the-art MRI system allows the development and application of the newest MR techniques at the molecular level, the cellular level, and clinically. This strategy will result in improvements in sensitivity and image quality, and reduction in scan time. In addition, high-resolution diffusion imaging, metabolic studies, as well as functional brain and cardiac imaging are being performed. We are already visualizing the coronary arteries, reducing the need for catheterization, and further metabolic insights into heart disease, neurological diseases, and cancer. The long-term impact will be clinically relevant advances in basic science, which will be reflected ultimately by improvements in health care, and patient outcomes.

This new clinical 3 Tesla magnetic resonance system replaced a 10 year old 1.5 Tesla system and will meet the stringent demands for cardiac, neurologic, and oncologic MR projects. Regarding the studies of the heart, we have recently observed that certain patients with chest pain but without angiographic coronary artery disease have handgrip exercise induced decreases in phosphocreatine/ATP using a standard 1.5 Tesla MR system. Phosphorus-31 spectroscopic studies can be performed with higher resolution at 3.0 Tesla. In addition, intracellular pH can be determined at 3T but not reliably at 1.5T. We believe that the P-31 “stress test” will add a new dimension to the cardiac magnetic resonance examination.

Finally, the public will benefit from this research in several ways. First, the direct application of NMR technology applied clinically to gain insights for optimizing both patient medical and therapeutic management. Another avenue of technical development regarding this noninvasive technology is to replace invasive and high-risk methods such as cardiac catheterization. Magnetic resonance is capable of imaging the arteries and the blood within them. Organs such as the heart, with its coronary arteries can be imaged using MR methods. Thus, standard coronary angiography, which requires cardiac catheterization, may be replaced by a noninvasive approach without the need for contrast agents. Coronary artery disease is the most prevalent cause of death in the U.S.

Historically, biomedical MRI has been limited to 0.5T to 1.5T MR system. However, UAB has been a pioneer in the field of high-field MR applications with the acquirement of a whole-body 4.1T research MR system in 1991. For over 10 years UAB has been focused on the advancement and applications of high-field MR. Furthermore, the trend in recent years in industry has been to focus on 3T MR system. The knowledge gained at 4.1T will be invaluable to the application at 3T. Research performed at 1.5T is not directly translated to the higher MR fields. However, work accomplished at 4.1T can be translated to 3T and thus have an immediate impact on the medical management of patients.