First images of hydrogen engine combustion captured
Images of hydrogen combustion have been captured for the first time in an internal combustion engine operating at real-world speeds and loads by engineers at DOE’s Argonne National Laboratory. This window into the inner workings of a hydrogen-powered engine is helping to optimize the engines for street use. Hydrogen-powered internal combustion engines are a low-cost, near-term technology, and can be the catalyst to building a hydrogen infrastructure for fuel cells. Researchers use ultraviolet imaging to capture images inside the running engine, and are also determining the most efficient and cleanest way to run the engine without knock or pre-ignition, another technical challenge.

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MINOS: Where did the muon neutrinos go?
The Main Injector Neutrino Oscillation Search collaboration at DOE’s Fermilab has presented new neutrino disappearance results that are consistent with neutrino oscillation. In this case, muon neutrinos can change into tau neutrinos or electron neutrinos, which can then escape detection by the 6,000-ton MINOS far detector located 450 miles away—through the earth—at the Soudan Underground Laboratory in Minnesota. Without neutrino oscillation, the far detector would have recorded about 336 muon neutrinos. Instead, the collaboration observed 215 muon neutrinos. With high precision and a large data sample over the next few years, MINOS will pave the way to a better understanding of neutrino oscillations.

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DOE, USDA collaborate on green energy
The departments of Energy and Agriculture are funding research at DOE’s Brookhaven Lab that could facilitate the production of renewable energy and materials from plants. The project falls under DOE’s “Genomes to Life” initiative, which aims to use genomic data to better understand fundamental biological processes and translate that knowledge into new technologies. Brookhaven biologists will study the genes and enzymes involved in processes that make certain plant polymers less digestible, thus inhibiting the conversion of biomass to useful energy/materials. Understanding these genes and enzymes may help scientists design new ways to improve the biomass properties of plants and promote the efficiency of the biomass-to-energy conversion process.

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INL tests cancer therapy isotope
An important test demonstrating production of a promising cancer therapy isotope, cesium-131, is under way using the Advanced Test Reactor at DOE’s Idaho National Laboratory. INL researchers inserted five capsules of barium carbonate into the reactor and bombarded them with neutrons. The irradiation will create cesium-131 through radioactive decay. The reactor irradiation is a key step in the isotope production process launched in December 2005, through a collaboration involving INL, IsoRay Medical, Inc. and Bannock Development Corporation. Officials expect the test to demonstrate the ATR can efficiently produce the quality and quantity of the isotope to meet IsoRay’s production need.

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Marvelous metamaterials

Costas Soukoulis, a senior physicist at DOE’s Ames Laboratory, and his collaborators at the University of Karlsruhe, Germany, are the first research group to fabricate a metamaterial that has a negative index of refraction at 1.5 micrometers—the smallest wavelength obtained to date.

Metamaterials are exotic, artificially created materials that can be manipulated to respond to electromagnetic waves in ways that natural materials cannot. They can refract light, or electromagnetic radiation, at a negative angle, allowing enhanced resolution in optical lenses, which could potentially lead to the development of a flat superlens with the power to see inside a human cell and diagnose disease in a baby still in the womb.

The development of a metamaterial with a negative index of refraction at 1.5 micrometers by Soukoulis and his Karlsruhe collaborators moves metamaterials into the near infrared region of the electromagnetic spectrum—very close to visible light, superior resolution and a wealth of potential applications.

Computer simulations developed by Soukoulis and his research team show how an electromagnetic wave evolves in time as it hits the surface of a metamaterial. The simulations reveal that the incoming beam is refracted in the negative direction as expected, but refraction does not take place immediately. Instead, the incoming electromagnetic wave is temporarily delayed and trapped at the boundary between the air and the metamaterial before it eventually moves in a negative direction.

Soukoulis says it is this trapping mechanism that causes the outer rays of the delayed beam to seem as though they are traveling faster than the speed of light. However, his calculations confirm that the speed of light is not violated by negative refraction. Movies developed by Thomas Koschny, an Ames Laboratory postdoctoral fellow working with Soukoulis, help clarify the interactions of electromagnetic radiation within metamaterials and can be viewed on the Web.

Submitted by DOE’s Ames Laboratory