Strongest non-destructive magnetic field: world record set at 100-tesla level

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World-record set at Magnetic Field Laboratory for non-destructive magnetic pulse

Researchers at LANL's biggest magnet facility set a new world record for the strongest magnetic field ever delivered by a nondestructive magnet in March 2012.

Working at LANL's National High Magnetic Field Laboratory (NHMFL), the scientists achieved a whopping 100.75 tesla—a magnetic field nearly 100 times more powerful than a junkyard magnet, and some 30 times stronger than the field delivered during a medical MRI scan.

The ability to create pulses of extremely high magnetic fields nondestructively (high-power magnets routinely rip themselves to pieces due to the large forces involved) provides researchers with an unprecedented tool for studying fundamental properties of materials, from metals and superconductors to semiconductors and insulators.

The 100-tesla level is roughly equivalent to 2 million times Earth's magnetic field.

“This is our moon shot”

"This is our moon shot, we've worked toward this for a decade and a half," said Chuck Mielke, director of the Pulsed Field Facility at Los Alamos. It was a scientific quest that has been pursued for years by scientists at competing magnet labs around the world, including Germany, France, China, and Japan.

The team used the 100-tesla pulsed, multi-shot magnet, a combination of seven coils sets weighing nearly 18,000 pounds and powered by a massive 1,200-megajoule motor generator. There are higher magnetic fields produced elsewhere, but the magnets that create such fields blow themselves to bits in the process.

The system at Los Alamos is instead designed to work nondestructively, in the intense 100-tesla realm, on a regular basis. The Los Alamos facility is one of three campuses forming the NHMFL.

Record magnetic field attracts new scientific questions

The ability to create pulses of extremely high magnetic fields nondestructively provides researchers with an unprecedented tool for studying a range of scientific questions: from how materials behave under the influence of very high magnetic fields, to research into the quantum behavior of phase transitions in solids.

Researchers can explore extremes of low temperature and high magnetic field, which will contribute to our understanding of superconductivity, magnetic-field-induced phase transitions, and so-called quantum critical points, in which small changes in materials properties at very low temperature have dramatic effects on physical behavior. The magnet could also be used as a nanoscale microscope.

The sound of the magnet

The sound that the 100 T multi-shot magnet makes is due to the electrical current modulation from the three-phase power converters (known as 12 pulse converters) and the harmonics associated with the chopping of the sinusoidal input power. The magnet vibrates at the electrical current frequencies multiplied by 12 (i.e. ~ 55 Hz x 12 = 660 Hz) hence making an audible sound. The generator is not run at full speed (1650 RPM instead of 1800 RPM) so the frequency is slightly lower than US Line frequency (i.e. 55 Hz instead of 60 Hz). A spectrograph of the sound from the magnet pulse shows the multiple harmonics as reddish horizontal bands as a function of time (attached).

NHMFL facilities, campuses, and sponsors

The Pulsed Field Facility at Los Alamos is one of three campuses of the National High Magnetic Field Laboratory, the other two being at Florida State University, Tallahassee (continuous fields, magnetic resonance, and general headquarters) and the University of Florida Gainesville (ultra-low temperatures at high magnetic fields). The NHMFL is sponsored primarily by the National Science Foundation, Division of Materials Research, with additional support from the State of Florida and the U.S. Department of Energy.


NNSA
National Nuclear Security Administration