Sanford Underground Research Facility

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Deep Thoughts

Notes from the underground by Communications Director Constance Walter

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Next-gen dark matter detector in a race to finish line

The race to build the most sensitive direct-detection dark matter experiment got a bit more competitive with the Department of Energy's approval of a key construction milestone on Feb. 9.

LUX-ZEPLIN (LZ), a next-generation dark matter detector, will replace the Large Underground Xenon (LUX) experiment, which recently was removed from its home on the 4850 Level of Sanford Lab. The Critical Decision 3 (CD-3) approval puts LZ on track to begin its deep-underground hunt for theoretical particles known as WIMPs in 2020.

"We got a strong endorsement to move forward quickly and to be the first to complete the next-generation dark matter detector," said Murdock "Gil" Gilchriese, LZ project director and a physicist at Lawrence Berkeley National Laboratory, the lead lab for the project.

The fast-moving schedule allows the U.S. to remain competitive with similar next-generation dark matter experiments planned in Italy and China. "The science is highly compelling, so it's being pursued by physicists all over the world," said Carter Hall, the spokesperson for the LZ collaboration and an associate professor of physics at the University of Maryland.

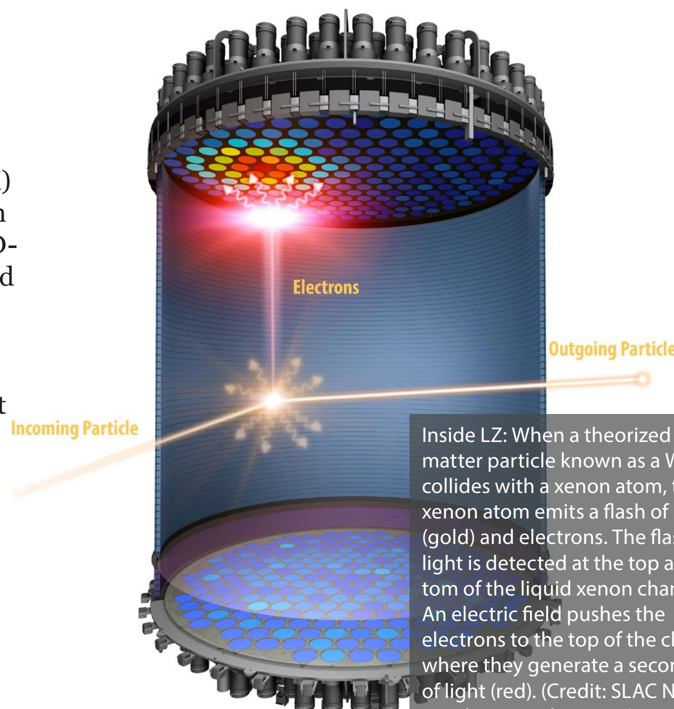
WIMPs (weakly interacting massive particles) are among the top prospects for explaining dark matter, which has only been observed through its gravitational effects on galaxies and clusters of galaxies. Believed to make up nearly 80 percent of all the matter in the universe, this "missing mass" is considered to be one of the most pressing questions in particle physics.

The new experiment will be installed in the same cavern and water tank that housed LUX. It will use 10 metric tons of ultra-purified liquid xenon, to tease out possible dark matter signals. By comparison, LUX used one-third of a ton of liquid xenon. LZ is expected to be 100 times more sensitive than LUX.

Installation will begin in 2018. The xenon needed for the project has been delivered or is under contract. Xenon gas, which is costly to produce, is used in lighting, medical imaging and anesthesia, space-vehicle propulsion systems and the electronics industry.

"South Dakota is proud to host the LZ experiment at Sanford Lab and to contribute 80 percent of the xenon for LZ," said Mike Headley, executive director of the South Dakota Science and Technology Authority (SDSTA), which oversees Sanford Lab. "Our facility work is underway and we're on track to support LZ's timeline."

A dust-filtering cleanroom is being prepared for LZ's assembly and a radon-reduction building is under construction at the South Dakota site—radon is a naturally occurring radioactive gas that could interfere with dark matter detection.



Inside LZ: When a theorized dark matter particle known as a WIMP collides with a xenon atom, the xenon atom emits a flash of light (gold) and electrons. The flash of light is detected at the top and bottom of the liquid xenon chamber. An electric field pushes the electrons to the top of the chamber, where they generate a second flash of light (red). (Credit: SLAC National Accelerator Laboratory)

"We have an excellent collaboration and team of engineers who are dedicated to the science and success of the project," said Kelly Hanzel, LZ project manager and a Berkeley Lab mechanical engineer. The latest approval milestone "is probably the most significant step so far," as it provides for the purchase of most of the major components in LZ's supporting systems.

During a video conference event between Fermilab and Sanford Lab, an inquisitive child asks Cabot-Ann Christofferson what it's like working underground on the Majorana Demonstrator experiment. Photos courtesy of Amanda Early, Fermilab.