The Search For **Dark Matter**

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What is LZ

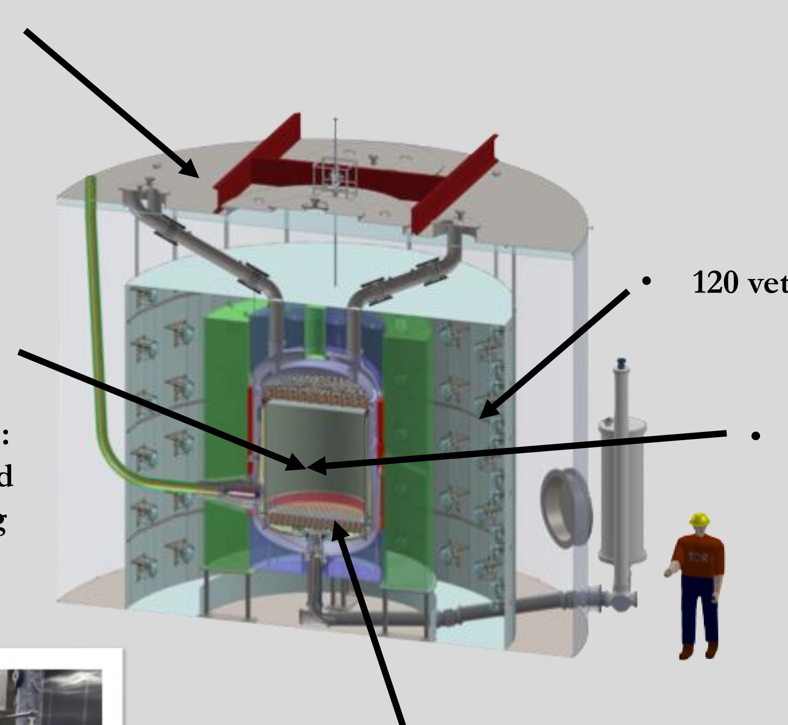
LUX-ZEPLIN better known as LZ began when two experiments combined; LUX and ZEPLIN-III.

- LUX or Large Underground Xenon Experiment, which held 340 kg of liquid Xenon.
- ZEPLIN was a detector that held 12 kg of Xenon.
- By *far* passing both is LUX-ZEPLIN which will hold 7,000 kg of liquid Xenon.

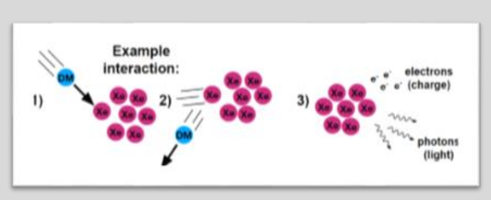
The Goal

- This experiment is an attempt to detect Weakly Interacting Massive Particles known as WIMPs, which are thought to be Dark matter. Dark Matter is one of the most pressing curiosities of Particle Physics. It is observed by its gravitational effects on galaxies and is believed to make up 80 percent of all mass in the universe yet we don't know much of anything about it.
- The Sanford Underground Research Facility (SURF) in Lead, South Dakota is at the heart of this LZ collaboration which more than 250 scientists from the U.S., U.K., Portugal, Russia, and Korea work in tandem on.
- In the end, LZ will be the most sensitive particle detector to ever exist. If it does not detect a WIMP it will mean scientists should start exploring other options.
- LZ will not be completed for several years, in the end though they will analyze data and look to find a reaction that suggests a WIMP had entered the cryostats (the main vessels of the detector).

The Design



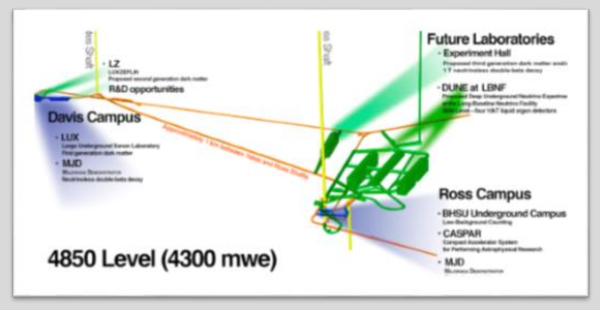
What the detector sees



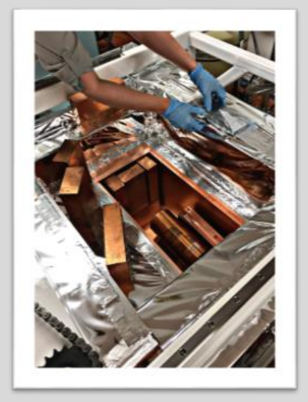
Why Location Matters

Underground

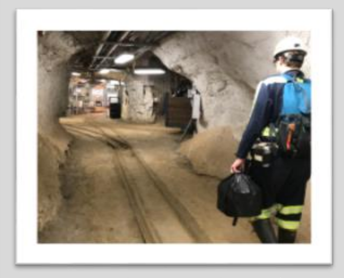
- The Black Hills Underground Campus (BHUC) is located a mile underground in an old mine shaft.
- In the BHUC we bring different materials that might be used in the experiment and put them in low-background-counters which use germanium crystals, to determine what material will create less "background" in the experiment.
- Background is false positives or reactions that the detector will pick up and distract from the important data. This has to be done underground so that the detectors are not effected by cosmic radiation.



Map of 4850



BHUC Underground Detector



Underground 4850' Level

Surface Lab

The surface lab is where the engineers and scientists working on the LZ collaboration meet from all over the world.

- In the reduced radon clean room (RCR) of the surface lab scientists and engineers work to build and test the Outer and Inner Cryostat Vessels for the detector. These vessels are assembled and tested above ground before they are brought a mile underground.
- Tests performed are cleanliness, leak testing, and practice assembling. It is important that everyone is prepared for when the cryostats are brought underground. Once underground all the parts and cryostat vessels should be completely ready.
- Part of preparing the cryostat is creating protective coats to layer over the entire vessel. This means creating large sheets to wrap them in. These sheets are made in a cleanroom where they will not be contaminated. It's necessary to make several layers in order to protect it from contamination. One layer will be removed at a time as it is being brought into the underground assembly room. There is a total of three layers on each cryostat. One to protect from elements and extreme dirty conditions and is taken off outside of the cleanroom. The next is taken off in an intermediate clean soft wall room and the last protection layer is taken off in its final destination.

Outer Cryostat

Outer Cryostat sealed

Engineers and Scientists Brainstorm

Why Dust Counting Matters

This detector is so sensitive even a speck of dust can let off radiation, specifically from Radon, that can ruin the experiments accuracy.

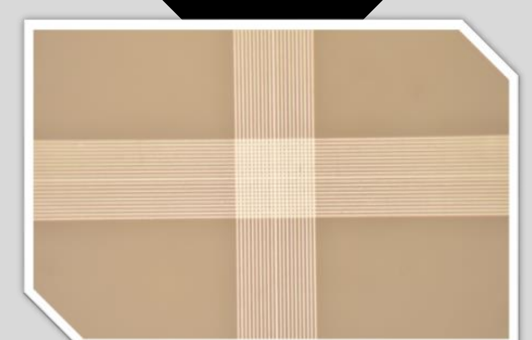
- Radon has a half-life of 22 years so if any was to touch the detector it would be a *very* long wait to continue the experiment
- In the surface lab we have several clean rooms that have intensive protocols for entry; such as what can be brought in, how clean it must be, dust monitoring, and air pressure.
- It's important to log when someone enters a clean room so that we can understand any abnormal data we collect through radon counters.
- Using sheets the parts of the detector are entered along with their exposure time (amount of time unwrapped and exposed to air) in the Radon Reduced Cleanroom.
- Collecting dust and compiling data on how much dust is collecting on surfaces is important to maintain the integrity of the detector.

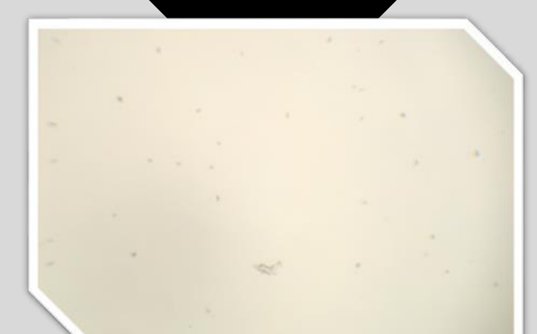
Process Described

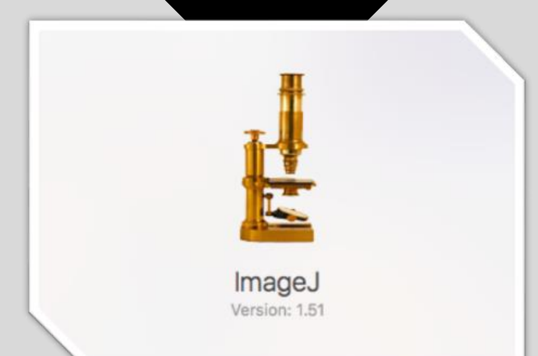
Dust analysis is prepared and analyzed in the Surface Lab.

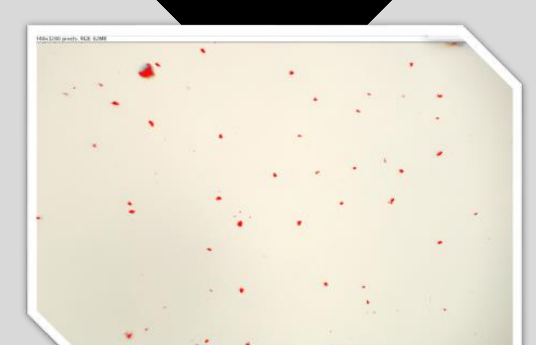
- To begin, glass slides are cleaned through a careful process that involves cleaning them with a high alcohol content and nitrogen.
- The clean slides are tested and confirmed clean enough before use.
- Slides are then deployed into the Radon Reduced Cleanroom where the cryostats are worked on.
- After the slide has collected dust for a set period of time, post analysis can begin.
- Analysis begins with taking images of the slide with a microscope.
- These images are then processed with a program that selects the dark areas of the image, dust.
- These images are then turned into a format which MATLAB takes and processes made to output data and analysis of the amount of dust collected.

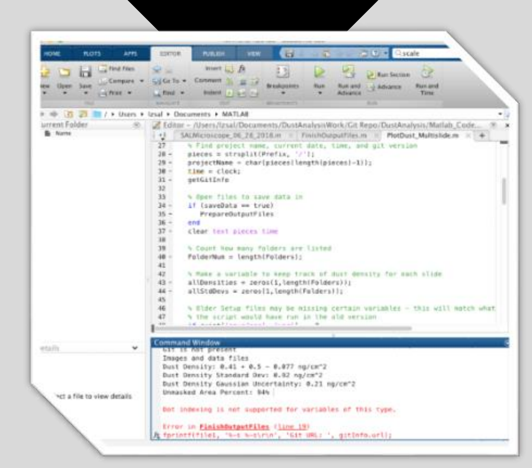
Dust Analysis











References

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- (n.d.). Retrieved from http://lz.lbl.gov/
- Hamilton, E. (n.d.). Dark matter detection receives 10-ton upgrade. Retrieved from https://news.wisc.edu/dark-matter-detection-receives-10-ton-upgrade/