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GRAN SASSO LABORATORIES: GERDA'S CHALLENGE TO MAJORANA'S NEUTRINO

The GERDA experiment at the INFN's Gran Sasso National Laboratories (LNGS) has reached a very important scientific milestone: it is the first and only experiment that can claim the title of "background free" experiment in the study of the extremely rare and never yet observed neutrinoless double beta decay. Measuring this process is both difficult and crucial.
There is a fundamental property of neutrinos that is currently still unknown: we do not know whether neutrinos are Majorana particles, in other words identical to their antiparticles. If they were, we should be able to observe a process, the double beta decay, which is forbidden by the Standard Model of elementary particles. Expected by many other theories, such as those created to explain the absence of antimatter in our universe, this decay is never observed experimentally. The detection of this very rare phenomenon offers the opportunity to investigate unexplored regions of nature and provide important clues to the discovery of New Physics beyond the Standard Model.
The search for neutrinoless double beta decay, however, implies a strenuous battle against other much more common natural events, "background processes", which simulate the sought signal, thus polluting it and making its detection difficult.
Following the latest improvements, and for the entire duration of the data collection, roughly 3 years, GERDA should record no background event in the search range set by the energy resolution of the detectors. GERDA is therefore one of the leading experiments in this field, thanks to its special germanium detectors: these are powerful devices for the search of neutrinoless double beta decay, because they allow to drastically reduce the decay search range and thus exclude events caused by non interesting radioactive decays. In particular, whilst 8% of natural germanium is made by isotope 76 - the only one among germanium ones that can originate a double beta decay - the percentage in the germanium detectors employed by GERDA is increased to 86%. This feature, obtained with a procedure similar to the uranium enrichment one, helps to reduce the background events with respect to the

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signal by a factor of 10.
GERDA is set up in the Gran Sasso Laboratories, where the overlying mountain shields the experiment from cosmic rays, which would create interference signals on the detector. The germanium detectors work within a cryostat containing 63 cubic meters of liquid argon at a temperature of -190 ° C, immersed in a container filled with 590 cubic meters of ultra-pure water. The argon and the water, free from contamination, act as shields against radiation coming from the external environment. The battle against the background events also entails a careful selection of all the material close to the detectors (cables, supports etc.), so that it may be free from radioactive contamination.
GERDA is a European collaboration involving more than 100 scientists from Germany, Italy, Russia, Switzerland, Poland and Belgium. Italian physicists contributed to the construction of the experiment, the data collection and the consequent analysis. The involvement of Italian industry was also very significant: Di Zio constructed the water tank, CAEN supplied the high voltage power supplies for the germanium diode, Tecnomec supplied the high voltage and signal cables.
GERDA will continue to operate until mid-2019, quadrupling the data obtained so far and remaining "background free". ■