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# MUTOMCA: A NEW PROJECT WITH MUON TOMOGRAPHY FOR NUCLEAR WASTE

Recreating in total safety a 3D map of the spent nuclear fuel produced by the nuclear power plants in Europe and stored in shielded casks, by using a technology developed from particle physics: this is the task of the MuTomCa (MUon TOmography for shielded CAsks) project. It implies the construction of a muon detector (muons are particles similar to electrons but with a mass about 200 times higher), capable of showing the interior of the shielded casks including the spent fuel assemblies in a very precise tomographic image while operating from the outside. The project is an international collaboration among the INFN, for Italy, the Jülich Research Center (FZJ) and the BGZ Company for Interim Storage, for Germany, and the European Atomic Energy Community (EURATOM).
In Europe, there are currently around 1500 casks to which this technology could be applied and the relevance of this issue will increase with phasing out nuclear energy production. Currently, no sufficiently precise method is available for a re-verification of spent fuel assemblies enclosed in thick-walled strongly shielded casks, where the inner fuel assemblies are mostly inaccessible to neutron and gamma ray detection as they are masked by the outer spent fuel assemblies. While X-rays, used in radiographs, cannot cross more than a few tens of centimeters, muons can pass through large thick layers of material, even a few kilometers. This characteristic allows the use of these particles to create three-dimensional images of large structures from the outside and in complete safety.
In the MuTomCa project context, a research team led by physicists from the Padua division of INFN, which also includes researchers from Genoa and Pavia, is working on the construction of a muon detector based on "drift tube" technology, a method often used to detect charged particles and it is used in the muon detectors of the LHC accelerator experiments at CERN, where it made a fundamental contribution, for example, to the discovery of the Higgs boson.
Once completed, the detector will consist of two modules each composed by six layers of 30 or 31 drift

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tubes filled with a particular mixture of gas. Each tube is equipped with a thin copper and beryllium wire in the centre at a voltage of 3000 V. As the cosmic muons pass, the detector is able to measure their position and direction with extreme precision: an information that makes it possible to reconstruct the internal image of the structure to be analyzed. The construction and assembly phase, in progress in Italy, will last about one year while the test phase will take place in Germany and will last about six months.
The first application of this technology dates back to the late 1960s, when it was used to study pyramids and, more recently, it was applied to the study of to volcanoes. Other applications of technologies related to cosmic muons can be found in the controls of means of transport to counteract nuclear smuggling in industrial applications to avoid accidents due to melting of radioactive sources in foundries and for the optimization of the cycle of blast furnaces. Moreover, the same technology could be used to study other types of nuclear waste stored in the past decades in concrete containers that need to be secured. ■