# Virtual lab for nuclear waste repository research

March 4 2014

A 360 degree presentation of a virtual model at the Fraunhofer IFF. Decisions can be arrived at more easily when everyone involved is able to view the details. Credit: Dirk Mahler

A nuclear waste repository must seal in radioactive waste safely for one million years. Researchers currently have to study them and their processes in real underground laboratories but a virtual underground laboratory will soon simplify their work.

The nuclear power phaseout in Germany is a done deal and is supposed to be finalized by 2022 at the latest. Where should the radioactive waste produced be put, though? Suitable sites for nuclear waste repositories have to be found as quickly as possible. This is not easy, though since waste is required to be sealed off from the biosphere for one million years. A potential site's real suitability as a nuclear waste repository can only be analyzed once such a repository has been designed, planned and studied together with its equipment modules. Various physical and chemical processes, which are very complex and interact, take place in a nuclear waste repository – the rock may be heated by the waste stored and gases may develop. Until now, researchers have studied such processes in underground laboratories such as the ones in Mont Terri in Switzerland or in Äspö in Sweden as well as in France and Belgium. Time and again, German researchers have to pack their bags and travel to the underground laboratories for their experiments where they test the quality of sealing systems for instance. The period of a study is limited, though, because none of these tests can be conducted for more than a few years.

## Laying out and studying deep geological repositories virtually

The most important nuclear waste repository research organizations – the Gesellschaft für Anlagen- und Reaktorsicherheit GRS, the Federal Institute for Geosciences and Natural Resources BGR and DBE Technology GmbH – therefore need to supplement real underground laboratories. They contracted researchers at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg the world's first virtual underground laboratory, VIRTUS. A software platform is the virtual underground laboratory's central component. It realistically represents all of the conditions there, whether the types of rocks in the soil or the physical or chemical processes that take place in a deep

geological repository. This enables researchers sitting at their desks to perform virtual experiments in a realistic scenario and to review plans and sites for nuclear waste re-
positories down to the minutest detail.

In a first step, the researchers recreate a site's geological formations. Since concrete sites for nuclear waste repositories do not exist yet, they work with a generic model – rock formations are structured realistically but do not recreate any real site. "After all, the first task is to develop the system and to test VIRTUS's performance on the basis of initial calculations," says Steffen Masik, engineer at the Fraunhofer IFF. Users can lay out a virtual deep geological repository in this rock formation. They have a great deal of freedom in the process: They can specify the depth, area, height and width of the repository. They can also import a repository complex created beforehand and specify the locations of boreholes and adits in which radioactive waste will be stored.

Once they have created a repository complex, the researchers can commence their studies – just like in a real underground laboratory and select an area of the deep geological repository. A special interface transfers the location selected and the repository data to a simulator, which computes, for instance, rises in temperature in the repository caused by the radioactive waste. The results are visualized in VIRTUS. Users can also display cross sections of the rock together with the temperatures there. Mechanical stresses and thus the probability of crack formation can also be computed. Researchers can closely examine permeability to water or other liquids and gases. VIRTUS displays all of the calculations together with the geological model. "The software visualizes the computed thermal, hydraulic and mechanical processes in a nuclear waste repository as well as their complex interactions," says Klaus Wieczorek, who works in the division of nuclear waste repository safety research at GRS and is heading the VIRTUS project.

VIRTUS is still in development at present. A first prototype is supposed to be publicly accessible at the end of April: In the future, visitors to the large, 360 degree projection system at the Virtual Development and Training Center VDTC in Magdeburg will be able to see the workings of a nuclear waste repository and the simulation results. "This is a good opportunity for us to win people's confidence in our work and to develop their understanding for decisions," says Wieczorek.

Provided by Fraunhofer-Gesellschaft

Citation: Virtual lab for nuclear waste repository research (2014, March 4) retrieved 23 May 2024 from https://phys.org/news/2014-03-virtual-lab-nuclear-repository.html