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News flash: Unique new facility at JRC-ITU to study nuclear materials properties

A new nuclear magnetic resonance (NMR) instrument dedicated to the study of radioactive and nuclear materials is being installed at the Institute for Transuranium Elements (JRC-ITU), one of seven research institutes of the European Commission's Joint Research Centre. The facility will focus on solid-state experiments on advanced and future nuclear fuel types. It will be unique in that its magnet will be suspended about 2 m off the ground, with a glove box underneath. A tube from the glove box will extend up through the bore of the magnet. This setup will enable magic-angle-spinning experiments, in which solid samples are spun at frequencies up to 70 kHz, to give high-resolution spectra of solid samples (powders).

To date, such experiments have been performed only on samples encased in ceramics or polystyrene to ensure their containment. The integrated glove box will permit investigations on powders in a safe environment without the risk of contamination. The experiments will be particularly useful for the study of radiation-damage in materials that might culminate in a mixture of amorphous and crystalline regions. Dedicated separate effects on damage generation and thermal recuperation will be achieved. This work is part of an international effort to recycle the actinides by separating them from the fission products and transforming them into new (fresh) fuel to be reused in the reactor (partitioning and transmutation). "The unique facility will be embedded in a NMR centre in the Karlsruhe region, where a second complementary laboratory focussing on liquid samples is being installed at the adjacent German centre, the Karlsruhe Institute of Technology (KIT)", says Thomas Fanghänel, Director of the JRC-ITU institute. "These two facilities will strengthen the resources available in Europe to study waste separation and basic nuclear material properties."

Nuclear magnetic resonance spectroscopy is worldwide the most used technique for determining chemical structures, but has historically seen limited use for studying nuclear fuel or waste materials. The main reasons are safety, principally because highly radioactive materials require special handling facilities. Furthermore, radioactive elements in nuclear materials are mostly paramagnetic and tend to generate very complex spectra that are difficult to interpret.
With the renewed interest in nuclear power and an increasing need to manage nuclear waste streams, several institutions are now developing additional NMR capacity dedicated to radioactive materials. The advantage over traditional techniques (such as scintillation counting) for studying radioactive materials is that NMR can provide detailed information on the chemical species and dynamics of a system. NMR is an excellent technique for the study of the properties and chemistry of the actinide f-block elements. The chemistry of these elements is young (50 years compared to several hundred years for the transition metals), providing an enormous potential to discover hitherto unknown or unreached properties.

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