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The New FRM-II Research Reactor in Munich

ABSTRACT

The new FRM-II (Forschungsreaktor München II), which became first critical in March 2004, is a high-performance research reactor to deliver essentially thermal neutrons for fundamental research and for other, e.g. industrial and medical, applications. So the FRM-II is not a prototype reactor to develop new lines of nuclear reactors, and the energy released in the nuclear fission reaction is not being used at all. It is also in contrast to big power plants that it is not a large thermal power which is important (to produce electricity economically) but rather a high power density which ultimately leads to a high neutron flux density at the position of the samples to be investigated or to be irradiated.

Whereas competitive high-flux research reactors worldwide are located in big (international) research centers and have thermal powers of about 60 to 100 MW, the FRM-II is operated by a university (Technische Universität München),

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whence the reactor power has been limited to 20 MW only. The target of realizing, nevertheless, a very high performance neutron source could be met by designing a particularly compact reactor core which is cooled by light water and placed in the center of a large heavy water moderator tank. The reactor core includes only one cylindrical fuel element with 243 mm diameter and 700 mm height of the active zone; the power density amounts to more than 1000 kW/liter. The fuel element contains a total of 8.5 kg of highly enriched uranium (HEU, with 93 % U235) in an uraniumsilicide-aluminum dispersion fuel of high density. In this way a reactor cycle of more than 52 full power days could be achieved with a maximum unperturbed thermal neutron flux in the D_2O moderator of $8 \cdot 10^{14}$ n/cm^2s. Initiated by politics a study is underway to investigate the possibility of a conversion of the FRM-II from HEU to MEU (medium enriched uranium) as subject to marginal penalties only. The FRM-II is fully protected with respect to the impact of a military or passenger aircraft.

The high flux of thermal neutrons in the D_2O moderator tank is being used in essentially two ways. Firstly, vertical tubes and rabbit systems allow the insertion of samples and their irradiation with neutrons directly in the D_2O tank, to produce radioactive isotopes, e.g. for radiopharmaca or nuclear activation analyses, or to dope large silicon crystals. Secondly, and much more important, horizontal and oblique beam tubes allow to extract beams of neutrons into the experimental hall and into an adjacent guide hall to perform neutron scattering experiments. In this way the atomic and molecular structure of samples as well as their dynamics (internal vibrations) can be investigated which is most interesting in broad fields of physics, biology, chemistry, geology, and materials and engineering sciences. Further fields of interest are related to the local magnetism in the samples, to internal stresses, to precipitations, etc.. Special cold and hot sources are installed in the D_2O tank to provide neutrons with energies lower and higher, respectively, than thermal. An uranium converter delivers high energetic fission neutrons for medical cancer treatment and for radiography and tomography with neutrons. Special facilities use the neutrons to produce highly intense beams of positrons or of heavy ions, and also a high density of ultracold neutrons. It is planned that ultimately about 30 to 35 experiments can be performed simultaneously at the FRM-II.

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