

The Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II) aims to convert its fuel from highly enriched uranium (HEU) to low enriched uranium (LEU) with an enrichment of less than 20%. This program is part of worldwide efforts to minimize the usage of HEU in research reactors. As a result, a novel fuel in the form of a highly dense uranium-molybdenum alloy (UMO) is being developed together with international partners. In Europe, this work is being coordinated in the HERACLES consortium.

In this context, the Professorship for Applied Nuclear Technologies is looking for a

## Master student in physics or engineering (m/f/d)

### Your tasks

At the Technical University of Munich, our group is actively engaged in the development and optimization of core concepts for the conversion of the FRM II research reactor. The conversion of FRM II from highly enriched uranium (HEU) to low enriched uranium (LEU) represents one of the most demanding challenges among high-performance research reactors worldwide. Nevertheless, by November 2022 it was demonstrated that a scientifically viable LEU core design for FRM II is achievable.

Achieving this conversion requires more than a change of fuel. The use of LEU necessitates a fundamentally modified fuel element design and an adapted core geometry. Consequently, the conversion entails a comprehensive reassessment of the reactor core, including neutronic performance, thermal-hydraulic behavior, and thermo-mechanical integrity. Our research therefore focuses on the coupled multi-physics analysis and optimization required to ensure that the converted reactor maintains its exceptional neutron performance while meeting the stringent safety and operational requirements. In the framework of an international benchmark collaboration involving Argonne National Laboratory (USA) and CEA Cadarache (France), we are offering an exciting opportunity for a motivated Master's student or working student in the field of computational mechanics, nuclear engineering, or applied physics. The benchmark aims to improve the predictive capability of structural and multiphysics simulation tools for nuclear irradiation experiments.

Understanding the thermo-mechanical and structural behavior of materials under irradiation is a key challenge in nuclear engineering. Reliable modelling approaches are essential for the design and safety assessment of advanced nuclear fuels and reactor components. In this project, simulation results generated by different international research institutes will be compared in a code-to-code benchmark study. The goal of this thesis is to model a representative irradiation test using ANSYS Mechanical. The benchmark focuses on the thermo-mechanical response of a test specimen exposed to irradiation-induced loads, thermal gradients, and material property evolution. Other participating institutes use different simulation tools (e.g., finite element or multiphysics codes), and your work will contribute to the comparison and validation of these approaches.

### The main tasks include:

- Literature review on irradiation-induced material behavior and modelling approaches
- Understanding the benchmark specifications and test geometry
- Development of a finite element model in ANSYS Mechanical
- Implementation of:
  - Thermal loading and heat transfer
  - Mechanical constraints and contact conditions
  - Irradiation-induced effects (e.g., swelling, creep, material degradation)
- Sensitivity studies and verification of modelling assumptions
- Comparison of simulation results with international benchmark participants
- Documentation and presentation of results in an international context

### Learning Outcomes

Through this project, the student will gain:

- Hands-on experience with advanced finite element simulations
- Knowledge of irradiation effects on materials
- Exposure to international nuclear research collaborations
- Skills in multiphysics modelling and validation
- Scientific writing and presentation experience

### Requirements

We are looking for a motivated student with:



- Background in mechanical engineering, physics, nuclear engineering, or a related field
- Interest in computational mechanics and simulation
- Basic knowledge of finite element methods
- Experience with ANSYS, Abaqus, COMSOL, or similar tools is an advantage
- Programming or scripting skills (Python, MATLAB, etc.) are beneficial
- Good English communication skills

For questions regarding the project, please contact Prof. Christian Reiter ([christian.reiter@frm2.tum.de](mailto:christian.reiter@frm2.tum.de)) or Dr. Kaltrina Shehu ([Kaltrina.shehu@frm2.tum.de](mailto:Kaltrina.shehu@frm2.tum.de)).