LITHUANIAN ENERGY INSTITUTE

ADMISSION TO PHD STUDIES FOR THE YEAR 2026

DOCTORAL RESEARCH TOPIC:

Safety and reliability assessment and investigation of the processes in the nuclear fusion facilities and particle accelerators

RESEARCH FIELD:

Energetics and Power Engineering (T 006)

BRIEF DESCRIPTION OF RESEARCH TOPIC:

**Exploring the Future of Energy: Nuclear Fusion and the Path to Sustainable Power**

The European Union is spearheading a groundbreaking research program in nuclear fusion, targeting a transformative shift in how we produce energy. This ambitious endeavour includes plans to begin the deuterium-tritium operation phase in the ITER research reactor by 2039 – a crucial step toward the eventual deployment of fusion as a practical and powerful energy source. Following ITER, the fusion power plant DEMO will be built on this progress, demonstrating not only the technological feasibility of fusion but also its economic viability as a sustainable energy solution.

ITER's mission is to prove that nuclear fusion can yield more energy than it consumes – a feat that, if achieved, would mark a revolutionary advancement in clean energy. DEMO, the next step, aims to take fusion from a scientific breakthrough to a commercially viable technology, ushering in a new era where fusion could reliably power our cities and industries.

Developing fusion technology is no small feat; it raises a host of complex scientific and technological challenges. By 2027, researchers are working to produce a conceptual design for DEMO, which requires an in-depth understanding of the physical, chemical, and nuclear processes that occur in fusion reactors. This knowledge is essential not only for creating effective technologies but also for ensuring their safety, longevity, and performance in real-world conditions.

Such issues will also need to be addressed when preparing for the decommissioning of fusion facilities. When planning the decommissioning processes of these facilities, it is essential to assess the fundamental safety principles to minimize radiation exposure to workers and the public during dismantling. The environment in which these decommissioning activities will take place may often be complex and subject to change; therefore, it must be carefully evaluated and managed to ensure the safety of all decommissioning operations.

In nuclear fusion devices, as plasma burns, the majority of the energy produced is carried by neutrons. These high-energy particles transfer energy to radiation-sensitive components, which then face intense stress and wear. Studying neutron transport and its interactions with reactor materials is crucial, as it determines how well these components can withstand the harsh environment inside the reactor. This research is complemented by investigations at particle accelerators like CERN's n_TOF facility, which allow scientists to study the effects of ionizing radiation on reactor materials. Additionally, the DONES project is dedicated to exploring how high-energy neutrons impact fusion materials, providing invaluable insights into durability and safety. The topic may also include the new installations' (related to fusion) probabilistic assessment and reliability research based on data science.

The aim of this research topic is to advance our understanding of the processes inside fusion reactors to develop innovative and safe technologies for energy generation. Key objectives include: analysing ITER and DEMO systems, conducting deterministic and probabilistic safety analyses or reliability estimation, exploring neutron transport and its effects on structural materials, and investigating residual heat and radiation dose power produced by neutron impact, as well as the development of decommissioning safety assessment principles.

PhD students engaging in this field will be at the cutting edge of fusion research, contributing to a pioneering effort to make fusion a viable and environmentally sustainable power source. This journey involves not only scientific inquiry but the chance to be part of an international mission to redefine energy for future generations.

**LEI researchers working in the field of nuclear fusion energy propose the following research topics for prospective PhD students:**

1. Monte Carlo based neutron transport and radiation safety studies at the CERN n_TOF facility;
2. Safety assessment of decommissioning technologies for fusion facilities;
3. Numerical studies of particle transport and interaction in the IFMIF-DONES facility using Monte Carlo methods;
4. New nuclear fusion installations' probabilistic assessment and reliability research based on data science.

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