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E02 : Materials for nuclear fission and fusion: challenges, performance, and prospects

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Invited Speakers: NICOLAS Timothée (CPHT), VARVENNE Céline (INSA Lyon), DIEZ Mathilde (CEA IRFM)

Sponsors: Federation de Recherche Fusion par Confinement Magnétique (FRFCM)

Content: The shift toward decarbonized energy sources makes nuclear power at the forefront of future energy production. Whether through fission—with existing reactors and innovative concepts (SMRs, AMRs, molten salt reactors, etc.)—or fusion—with advancements in ITER, tokamaks, and other magnetic confinement devices—both pathways share a critical requirement: mastering and ensuring the durability of materials exposed to extreme environments.

This mini-symposium aims to bring together researchers and professionals working on materials for fission and fusion, fostering dialogue around shared challenges. These include irradiation, corrosion, intense thermal gradients, energetic particle fluxes, and the resulting structural and chemical damage.

The event will address materials for fission reactors, exploring their behavior under irradiation, strategies for extending the lifespan of current facilities, and the challenges posed by emerging concepts such as fast reactors, molten salt reactors, and SMRs/AMRs. Special emphasis will be placed on the need for innovative characterization techniques to tackle these issues.

Additionally, plasma-facing materials for nuclear fusion will be a key focus, with discussions on plasma-wall interactions (erosion, deposition, particle and heat transport), as well as the development and characterization of PFMs (Plasma Facing Materials) and their coatings. The coupled effects of plasma and neutron exposure on material microstructure and properties will also be examined, considering the specificities of different fusion devices (tokamaks, stellarators, etc.).

Finally, a cross-cutting approach will highlight synergies between fission and fusion, comparing extreme environments and damage mechanisms. Advanced characterization tools, multi-scale modeling, and the development of innovative materials (refractory alloys, ceramics, composites) will be discussed, along with mitigation strategies to ensure the performance and safety of nuclear installations.