Abstract

Multi-mode Muon-Neutron 3-D Imaging of SNF Canisters

The proposed project aims to develop and validate a multi-modal imaging approach for assessing the integrity of spent nuclear fuel (SNF) stored in sealed stainless-steel canisters. As the storage of SNF extends beyond initial licensing periods, concerns arise about fuel degradation and structural integrity, especially during transport to interim storage facilities (CISF). Traditional methods lack the ability to verify the internal condition of SNF within these sealed canisters, presenting a challenge for ensuring safety and regulatory compliance.

To address this, our project combines passive muon tomography with active neutron imaging to improve internal imaging speed and precision. Muon tomography offers deep penetrability, while neutron imaging enhances spatial resolution. Together, these modalities allow sub-centimeter resolution imaging within a single day. Initially, passive muon tomography will be applied at reactor sites, followed by rapid active neutron interrogation at CISF locations. This sequential approach supports criticality safety and efficient damage detection without opening canisters. If successful, this technology will significantly improve SNF inspection capabilities, aiding regulatory approval for extended storage and transport and supporting broader SNF management policies.