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Autopsy of the n_TOF spallation target at CERN

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The neutron time-of-flight (n_TOF) facility at the European Laboratory for Particle Physics (CERN) functions as a pulsed white-spectrum neutron spallation source. The facility's target, composed of pure lead, is impacted by a high-intensity 20 GeV/c pulsed proton beam. The facility enables the study of neutron-nucleus interactions across a wide spectrum of neutron kinetic energies, ranging from a few meV to several GeV. Such studies have significant applications in nuclear astrophysics, nuclear technology, and medical research.
Following the end-of-life of the second-generation target (target #2), the facility underwent substantial upgrades during CERN's Long Shutdown 2 (LS2, 2019–2020), culminating in the installation of a third-generation neutron target (target #3), operational since 2021.
A major enhancement in the third-generation target is the cooling technology, transitioning from water to gaseous nitrogen as the coolant medium to minimise erosion, corrosion, and contamination. Ensuring the structural integrity and performance of these targets over time is crucial for operational efficiency and safety. The creep behaviour of pure lead at high operational temperatures is particularly critical for long-term use. Additionally, the spent target must be packaged to be conform to the Host States requirements for the conditioning of radioactive waste.
To investigate the effect of long-term irradiation on Target #2 and to prepare it for its conditioning, a waste packaging and autopsy project for n_TOF Target #2 was initiated in 2022 and executed in 2024. Given the high radiation dose rate of the spent target after ten years of operation, the autopsy was conducted entirely remotely using a robotic system. This contribution details the methodologies, preparations, and techniques implemented, emphasising non-destructive autopsy methods such as visual inspections, ultrasonic testing, and 3D measurements. These non-destructive testing (NDT) techniques enable thorough internal inspection, identifying defects like cracks, voids, deformations, and material degradation while significantly mitigating the risk of contamination spread.
This contribution also outlines the waste packaging process and the subsequent disposal pathway.

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