Contribution ID: **212** Type: **Oral Presentation**

Detecting Anomalies in Measured Thermal Neutron Flux Profiles of SAFARI-1 Research Reactor.

Tuesday 8 July 2025 10:50 (20 minutes)

The accurate measurement, analysis, and correct interpretation of the neutron flux distribution within the reactor core are essential for reactor safety, optimum performance, and understanding of reactor operations. In the SAFARI-1 research reactor, axial thermal neutron flux profiles of fuel-containing assemblies are measured at the beginning of each operational cycle by activating natural copper wires. This study investigates the variation in measured flux profiles by considering the movement of the control rod bank and copper wire axial positioning. The analysis is focused on the key features of the neutron flux profile: the bottom minimum, peak maximum, and top minimum and their axial location, with the goal of using this information to identify inadvertently axially shifted measurements. The research approach involved data preprocessing, visualization, and statistical analysis. The analysis produced 1D, 2D, and 3D flux representations, which can be related to the control rod bank movement, axial wire insertion in the fuel-containing assemblies, and fuel assembly position. A polynomial fit was applied to estimate the location of the flux profile's key features, and the distribution of these points as well as their correlation to bank positions were analysed. The standard deviation along with the Median Absolute Deviation and Pearson's Correlation Coefficient were used to characterize the sensitivity of the flux profiles to control bank positions. Results of the study show that peak maximum points exhibit higher variability and a stronger positive correlation to the bank positions than the bottom and top minimum points. The bottom minimum points have lower variability and are less correlated to the bank positions. However, this is due to some points missing in this case, causing inconsistency and biased results. The top minimum points remain consistent and positively correlate to the bank positions and may thereby be the most suited for the measurement shift characterization. This study's findings demonstrate the effectiveness of the proposed approach in identifying and correcting the shift in flux profile measurements resulting from improper copper wire insertion. The study ensures a more accurate interpretation of neutron flux profiles by distinguishing the actual variations from apparent anomalies.

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Session Classification: Nuclear, Particle and Radiation Physics-1

Track Classification: Track B - Nuclear, Particle and Radiation Physics