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#04-77 Assessment of irradiation performance in the Jules Horowitz Reactor (JHR) using the CARMEN measuring device

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This paper deals with the assessment of irradiation conditions in various experimental positions in the Jules Horowitz Reactor core and reflector. For this purpose, the CARMEN device is foreseen to measure neutron and gamma flux and nuclear heating in the experimental channels of the JHR [1]. CARMEN is an axially mobile measuring system composed of two fission chambers sensitive to both fast and thermal neutrons, an ionisation chamber sensitive to gamma flux and an aluminium-based calorimeter for nuclear heating measurement. This allows for very detailed axial characterization of irradiation conditions in various radial experimental positions. Actually, the measurements performed with this device can serve as a preliminary assessment of "unperturbed irradiation conditions", before the introduction of the real experimental device at that location. The present study aims at reproducing CARMEN measurements by simulation and connecting them to the irradiation conditions expected in MICA and OCCITANE devices - which are respectively devoted to in-core and out-core experiments for the irradiation of steel materials.

The OCCITANE device provides spectral tailoring capabilities in order to be representative of the neutron spectrum in Reactor Pressure Vessels, and offers regulated temperature conditions by limiting nuclear heating, thanks to neutron and gamma screens. The present study evaluates the correlation between the measurements obtained by the CARMEN device, in unperturbed conditions, and specific irradiation characteristics occurring locally, inside the experimental loading of the device. OCCITANE capsule must be able to reproduce a subset of irradiation conditions identical to those of OSIRIS to pursue irradiation programs, in connection with already existing experimental data. As a preliminary step before examining JHR experimental positions, the present work first evaluates the transfer function between the measurements of nuclear heating in OSIRIS reactor - performed inside a water channel in the reflector, thanks to a graphite sample calorimeter [2] - and the real irradiation conditions finally obtained in the IRMA capsule.

Neutron and photon transport calculations were carried out in critical mode by means of Monte-Carlo simulations, using the TRIPOLI-4® code. The advanced modelling of nuclear heating in the calorimeter requires the use of four-particle-type Monte Carlo simulations (involving neutron, photon, electron and positon). Regarding nuclear heating in steel materials, sensitivity studies were conducted to discriminate the respective contribution of gammas originating from the core and gammas resulting from the radiative capture in iron.

References

[1] Lyoussi et al., "Advanced methodology and instrumentation for accurate on line measurements of neutron, photon and nuclear heating parameters inside Jules Horowitz MTR reactor", in Proceedings of RRFM ' 12, Prague, Czech Republic, Mar. 2012.

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