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#10-28 Neutron instrumentation of the LFR-30: case of the ex-vessel flux monitoring system

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The development of next-generation nuclear reactors, particularly those using lead as a coolant, has opened up new possibilities in reactor design, safety, and efficiency. One of the most critical aspects of ensuring the safe and effective operation of these reactors is the development of advanced neutron instrumentation systems. Traditional neutron monitoring technologies face significant challenges in the harsh environments presented by lead-cooled fast reactors (LFRs), which operate at high temperatures and involve complex neutron flux profiles due to the lack of moderation compared to traditional reactors such as Light Water Reactors (LWRs). Thus, neutron instrumentation tailored specifically for these reactors is, therefore, essential to enhance both performance monitoring and safety protocols.

Within this framework, a collaboration between newcleo and Photonis started in mid-2022, to define the most suitable solution to address the challenges of both in-vessel and ex-vessel neutron flux monitoring of the LFR-30 prototype, currently being designed by newcleo. This paper deals with ex-vessel instrumentation for intermediate and power monitoring, while future studies will tackle the in-vessel instrumentation.

After briefly presenting the main features of the LFR-30 reactor, the neutron instrumentation strategy is introduced, and illustrates how the neutron flux is measured during the different operating phases. From there, a focus is made on the requirements to be fulfilled by neutron detectors located outside of the core vessel: these requirements encompass temperature, humidity, neutron spectrum, gamma exposure, mechanical integration, electrical signals to be delivered, etc. Based on these specifications, the solutions designed for intermediate and power monitoring are both presented.

The following steps will include prototyping phases of the above-mentioned detection systems to ensure manufacturability, and then incremental testing of the neutron detection system, from elementary separate-effect experiments (irradiation with a calibrated neutron / gamma source at room temperature, electrical tests at room temperature; thermal tests; etc.) to full-scale experiments (irradiation performed on nuclear facilities with environmental conditions representative of expected operating conditions on the LFR-30).

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