Contribution ID: **23** Type: **Oral**

The science objectives and basis of the LIBRTI tritium breeding test facility

Thursday 4 September 2025 14:30 (30 minutes)

Fuel (tritium) self-sufficiency is a critical requirement for the successful realisation of fusion as a viable energy source. More urgently, even the next generation of fusion experiments and prototype plants may be unable to rely on non-fusion sources of tritium to supply start-up or top-up inventories of tritium, in other words, they are likely to need to be self-sufficient in tritium almost as soon as they begin operating and start burning tritium. Primarily for this reason, UK Atomic Energy Authority has been awarded ~£200M to design and build, by 2028, a facility to provide a test platform for tritium breeding technologies to enable the research needed to derisk the solutions for tritium breeding for UK's own prototype power plant, STEP, as well as for global fusion development. The facility will be based around a compact neutron source, initially delivering of the order of 10^{13} n/s from DT reactions. Tritium breeding mock-up experiments at the m^3 scale are being developed in partnership with fusion industry, while a multiphysics digital modelling platform is being constructed in parallel –a digital platform that will be used to guide experimental design and be subsequently validated in its predictions of tritium production and recovery by the experimental measurements on LIBRTI.
This paper will describe the science basis for LIBRTI, explaining the motivation behind the programme and detailing a preliminary concept for one possible experiment, which has been used to validate the measurability of tritium production from LIBRTI experiments. These initial model tests demonstrate that not only will LIBRTI experiments produce measurable amounts of tritium, but, further, that experiments will be able to access time-resolved tritium recovery rates without being contaminated by the adjacent, tritium-based neutron source. This is an important validation of the engineering design choices for the facility, which will begin construction in 2025.

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Session Classification: Topic III

Track Classification: Track III: Testing and nuclear qualification