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OpenMC modelling of tritium breeding experiments

As part of the LIBRTI programme, the University of Birmingham is developing capability to (a) breed tritium from lithium ceramic in a metal capsule with the HF-ADNeF neutron source [1] and (b) detect tritium with a tritium bubbler and liquid scintillator system. To predict tritium activity, an OpenMC [2] model of the facility has been developed using the existing HF-ADNeF source term developed at Birmingham [3]. The model predictions should be comparable to experimental results and allow further investigation into where the tritium escapes between breeding and measurement.

The OpenMC model allows multiple parameters to be easily adjusted depending on the experiment being run: including ceramic pebble packing density, pebble size, ceramic composition, capsule composition, and the incident neutron spectrum. The neutron spectrum is dependent on the incident proton energy on the HF-ADNeF target and the shielding surrounding the experiment. Model outputs can include the rate of tritium bred, rate of heating, and the neutron spectrum inside the ceramics. Uncertainties on the outputs are propagated from the specific reaction nuclear data and Monte-Carlo statistics. OpenMC is an ideal tool for neutronics modelling of ceramic tritium breeding experiments, although validation of the model and further development of some methods is necessary.

[1] HF-ADNeF: <https://www.nnuf.ac.uk/high-flux-accelerator-driven-neutron-facility>

[2] OpenMC paper: <https://doi.org/10.1016/j.anucene.2014.07.048>

[3] The HF-ADNeF source term: https://github.com/mconroy101/UOB_HFNF/

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