# Implremenation of On-the-Fly Doppler Broadening in MCNP5 for Multiphysics Simulation of Nuclear Reactors

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**ABSTRACT**

This project involves the implementation of an "on-the-fly" Doppler broadening capability for MCNP5. This will allow MCNP5 to account for temperature feedback at arbitrary temperatures, without the need to generate cross sections at any temperature except 0K. Currently, a user must generate cross section sets for MCNP5 at a number of temperatures that characterizes the reactor configuration being analyzed. If a given material region is at a temperature for which there is no cross section set, the user either accepts the errors that will occur with the wrong temperature or takes the time to generate additional cross section sets. However, for realistic, detailed reactor calculations, Monte Carlo codes may comprise the neutronics portion of a multi-physics simulation involving thermal-hydraulic feedback to adjust temperatures and densities. In a light water reactor (LWR), this process can result in tens of thousands of material temperatures for which broadened cross sections are needed. Therefore, the cost, effort, and storage required to model temperature feedback in a full-core reactor may be prohibitive unless more approximate methods are used, such as interpolation between cross section sets. It has recently been shown that it is feasible to store only 0K cross sections for use by the Monte Carlo code (MCNP5). The idea is to Doppler broaden the 0K cross sections "on-the-fly" during the random walk of the neutron. In other words, if a neutron enters a material region that is at some temperature T, the cross sections for that material are *immediately* generated by Doppler broadening the 0K cross sections to the temperature T for all isotopes in that particular region. There are no pre-generated cross section sets except for the set at 0K. It has also been shown that "on-the-fly" Doppler broadening has a negligible impact on computational time. The implication of this development is that coupled neutronics calculations with temperature feedback can be done at exactly the temperature predicted by the thermal module, not an interpolated temperature. This reduces the truncation error associated with using a cross section set that is generated at a different temperature and simplifies the problem setup and minimizes memory demand, because only 0K cross sections are needed for any isotope.

This is a multiple partner project with the University of Michigan as the lead institution and Oak Ridge and Los Alamos National Laboratories as partners.