Enhanced Micro-Pocket Fission Detector (MPFD) for High Temperature Reactors

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ABSTRACT:

This new project focuses on fabrication and characterization of high temperature fission chambers that provide high-sensitivity, high-temperature (up to at least 800 °C) neutron flux monitoring technology that are suitable for use in high-temperature advanced reactors. During the last three years, our team, which includes researchers from a US national laboratory (the lead organization), a university, and an international research institute, has completed the design of a compact MPFD, which is based on a university design that was developed, patented, and demonstrated in their university research reactor. Final efforts are underway to complete fabrication and testing of this new MPFD prototype. FY-14 efforts of this nearly complete NEET-funded project will ensure that this unique sensor is capable of simultaneously measuring fast flux, thermal flux, and temperature in a compact package (< 0.22 inches in diameter). Prior evaluations of initial university-developed MPFD prototypes demonstrate that these sensors are capable of yielding accurate measurements for <u>seven orders</u> of magnitude in a research reactor (maximum flux of 10^{12} n/cm^2-sec). Thus, there is high confidence in their ability to monitor flux from startup to full power in a high temperature reactor (up to 10^{13} n/cm^2-sec). During the remainder of FY14, this team will complete enhanced MPFD long-duration performance tests in laboratory furnaces at temperatures up to 500 °C and irradiation testing in a research reactor. The proposed new three-year project will focus on evaluating MPFD designs that incorporate high temperature materials, such as the use of a Nb-1Zr sheath and specialized fabrication techniques that are often used in similarly developed sensors that have been successfully deployed in materials testing reactors (MTRs). Fabrication techniques suggested by ORNL to ensure sensor survivability at temperatures up to at least 800 °C (if not higher) will also be incorporated where applicable. In addition, supplemental research will be performed to evaluate the potential for connecting multiple MPFDs in a single sensor package so that temperature and axial flux profile data can be obtained simultaneously. Such data are needed to validate new multi-scale / multi-physics codes and meet several critical needs identified in Appendix D of this Funding Opportunity Announcement.