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A Fusion Prototypic Neutron Source for Near-Term Fusion Material Testing

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The development of fusion energy requires high-performance structural, functional, and plasma facing materials that can withstand the damaging effects of fusion neutrons. Further advancement of the scientific understanding of candidate materials requires a testing environment more prototypic of a future nuclear fusion device. The neutron energy spectrum of current irradiation facilities produce different transmutation rates, which can cause drastically different mechanical and thermal property evolution. In 2018, a US fusion materials community workshop affirmed that a Fusion Prototypic Neutron Source (FPNS) focused on the scientific understanding of material degradation in a fusion environment was a priority and determined the minimum parameters required to advance the development of fusion materials. Parameters include: damage rate of 8–11 dpa/year (Fe); ˜10 appm He/dpa (Fe); sample volume of $\geq$50 cm^3; three zones of 300–1000 C; and a flux gradient of $\leq$20%/cm. The goal of FPNS is to provide a prototypic neutron energy spectrum and sufficient fluence in a small sample volume using cost-effective technology that can be commission in the next 5-10 years. DOE Fusion Energy Sciences commissioned the conceptual evaluation of three mature technologies: D-Li stripping reaction; D-T gas target neutron source; and spallation neutron source. This presentation will discuss the material science motivation, a brief history, the three concepts currently being considered, and next steps.

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