Summary of Proposed Research

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I propose an Intensity Frontier Fellowship to support my work on the development of External Neutron Calibration Source for DUNE liquid argon TPC. The proposed research is a new approach of calibrating the energy deposition for DUNE TPC, which takes advantage of a remarkable property of argon - the near transparency to neutrons with an energy near 57 keV due to an anti-resonance "notch" in the cross-section. This concept is a new idea that originated at UC Davis and has been endorsed by the Calibration TF. It addresses the challenges and difficulties for energy deposition calibration in large-scale liquid argon detectors such as DUNE. I have formed a strong working group consisting of students, postdocs, and physicists. We are making a rapid progress to overcome the challenges noted in the Research Statement. Based on the initial encouraging results from the feasibility study I led, this new calibration strategy has now been written to the DUNE CDR. Further design, optimization, and testing efforts are now needed for the DUNE TDR which is due in spring next year. I propose to work at Fermilab for 6 months to design the neutron source and plan future relevant studies needed for the project. If successful, the proposed research will demonstrate a new calibration technique for large-scale liquid-argon neutrino detectors, which will be an enormous benefit to supporting DUNE and other liquid-argon based experiments.

The proposed research will take place in three stages. In the first stage, I will perform simulations to design the neutron source, based on which I plan to develop two new proposals for the future studies beyond the Intensity Frontier Fellowship. In the second stage, I plan to do an initial moderator/filter at Fermilab or other places where a neutron beam is available. Lastly, in the third stage, I will come up with a realistic engineering design for building a prototype and complete the DUNE TDR. The planned timeline of this project fits the fellowship period very well, and the interaction with the liquid argon detector experts at Fermilab would greatly facilitate the design effort. The ongoing and planned relevant studies, such as the low energy neutron capture and scattering cross-section measurements in argon, are of great interest to the supernova search community in DUNE collaboration. Several new research proposals and journal publications are expected to be initiated by this research. In addition to the main proposed research, my other activities will involve the supports on the ProtoDUNE single phase experiment at CERN and the ANNIE experiment at Fermilab. I will continue working on the online monitoring system for ProtoDUNE. If ANNIE starts taking Phase II data, I will also work on the reconstruction and data analysis. My presence at Fermilab supported by this fellowship will be crucial for me to be able to lead these efforts.