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## RESEARCH STATEMENT

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My research objective is the experimental exploration of the Standard Model (SM) of particles and fields with a focus on the neutrino physics sector. One of the measurements currently generating a great deal of interest in high-energy physics is the neutrino mixing angle  $\theta_{13}$ . Water Cherenkov neutrino detectors, such as Super-Kamiokande and SNO, have provided strong evidence for oscillation between flavor eigenstates ( $e$ ,  $\mu$ ,  $\tau$ ) in both atmospheric and solar neutrinos, implying non-degenerate mass eigenstates (1, 2, 3) mixing between at least two of the three flavors of neutrinos [1] [2]. Mass splittings  $(\Delta m_{12})^2$  and  $(\Delta m_{23})^2$  and mixing angles  $\theta_{12}$  and  $\theta_{23}$  have been constrained to be non-zero. The data favor the Large Mixing Angle (LMA) model, which requires at least three light massive neutrinos participating in the oscillations and has the two first-order mixing angles  $\theta_{12}$  and  $\theta_{23}$  both large [3]. Reactor neutrino disappearance experiments with a single far detector, such as KamLAND and CHOOZ, have confirmed the LMA solution and set an upper limit on the sub-leading order parameter  $\sin^2 2\theta_{13} < 0.1$  for large  $(\Delta m_{13})^2$  [4] [5].

Although it is small, establishing  $\sin^2 2\theta_{13} > 0$  allows for genuine three-flavor effects, such as leptonic CP violation, in the neutrino sector. One proposed type of experiment is the long-baseline “superbeam,” which uses a conventional accelerator to produce large numbers of muon neutrinos ( $\nu_\mu$ ) travelling toward a far detector and searches for reactions in the detector implying the appearance of electron neutrinos ( $\nu_e$ ) in the beam [6]. Several of these experiments have been proposed; however, the physics reach is estimated to be limited to  $\sin^2 2\theta_{13} \sim 0.01$ , due to an irreducible  $\nu_e$  contamination in the  $\nu_\mu$  beam, and they suffer from correlations between  $\sin^2 2\theta_{13}$  and unmeasured parameters in the appearance signal. An alternate experiment which could measure  $\sin^2 2\theta_{13}$  with equal sensitivity more cheaply and quickly is a next-generation reactor neutrino disappearance experiment using a near-and-far detector array. This type of experiment provides a direct measurement of  $\sin^2 2\theta_{13}$  without correlations in its disappearance signal [7].

The Double Chooz experiment, located at the Chooz B commercial nuclear power plant in Chooz, France, is scheduled to make the first measurement of  $\theta_{13}$  beyond the current best limit. Double Chooz has a near (far) detector located at an average distance of 410 (1050) m from the two reactor cores, with the sensitivity goal of  $\sin^2 2\theta_{13} < 0.06$  after 1.5 years of data-taking with the far detector alone and  $\sin^2 2\theta_{13} < 0.03$  after 3 years of near+far detector data [8]. My contribution to the Double Chooz experiment is the development and construction of the muon outer veto (OV) and tracker for both near and far detectors. The OV modules are vital to the expected sensitivity by the suppression of correlated neutron background due to the large coverage over the neutrino target detector and by allowing study via the muon tracking capability of the muon production of long-lived isotopes, such as  ${}^9\text{Li}$ , whose decays cause correlated  $\beta$ +neutron background. I maintain the C++ software which simulates the OV physics in the Double Chooz Monte Carlo. I am responsible for the quality control and production release validation of the entire Double Chooz offline software, including leading the quality control group in development of new diagnostic and analysis tools. I am also working on all aspects of the final Double Chooz measurement of  $\theta_{13}$ , including simulation of signal and background events, understanding the detector energy scale, and development of the final fit to extract  $\sin^2 2\theta_{13}$ .

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## REFERENCES

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