Contribution ID: **131** Type: **not specified**

LENS—Low-Energy Solar Neutrino Spectrometer: Principles of Detection and Background Suppression*

LENS is a low energy solar neutrino detector that will measure the solar neutrino spectrum above 115 keV, >95% of the solar neutrino flux, in real time. The objective is to measure the model independent inferred solar neutrino luminosity, test the current LMA-MSW oscillation model, probe the temperature profile of solar energy production, as well as search for active-sterile neutrino mixing using an artificial neutrino source. The fundamental neutrino reaction in LENS is charged-current based capture on 115In detected in a liquid scintillator medium. The reaction yields the prompt emission of an electron and the delayed emission of 2 gamma rays that serve as a time & space coincidence tag. Sufficient spatial resolution is used to exploit this signature and suppress background, particularly due to 115In beta decay. A novel design of optical segmentation (Scintillation Lattice or SL) channels the signal light along the three primary axes. The channeling is achieved via total internal reflection by suitable low index gaps in the segmentation. The spatial resolution of a nuclear event is obtained digitally, much more precisely than possible by common time of flight methods. Advanced Geant4 analysis methods have been developed to suppress adequately the severe background due to 115In beta decay, achieving at the same time high detection efficiency. LENS is now in the prototype phase— miniLENS which will demonstrate the lattice design, allow benchmarking of the LENS Monte-Carlo analysis, test Indium liquid scintillator fabrication, and test electronics configurations for scale up routes to the full scale LENS detector.

*This work was funded by— the National Science Foundation, Virginia Tech, LA Board of Regents and Louisiana State University. Brookhaven National Laboratory is funded by the Department of Energy.

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