# Letter of Intent for Operation of LENS- Low Energy Neutrino Spectrometer At the Homestake-DUSEL Underground Laboratory

**Objective:** To measure precisely (~3-4%) the Neutrino Luminosity of the Sun by observing the low energy part of the solar neutrino spectrum including those from the fundamental proton-proton reaction. **Experimental Tool:** We intend to employ the LENS detector, based on tagged neutrino capture driven by the CC weak currents. The capture reaction uses a target of natural Indium:

***_$_e$ + $^{115}$In □ e$^-$ + (_ =4.76 µs) 2 _ + $^{115}$Sn.***

This reaction is unique because: ***1)*** The Q value is only 114 keV, the lowest known for a CC _ capture. LENS is thus sensitive to most of the pp _ continuum (0-420 keV). ***2)*** The natural abundance of $^{115}$In is ~96%. ***3)*** The prompt electron is followed by a characteristic tag of 2 _'s after a mean delay of _ = 4.76 µs that provides a powerful suppressant of background. ***4)*** It provides a prompt e$^-$ signal with energy E(e$^-$) = E(_) – Q which yields the incident _ spectrum as in the simulated result expected from LENS in Fig. 1.

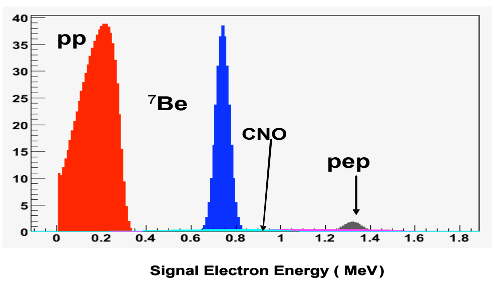
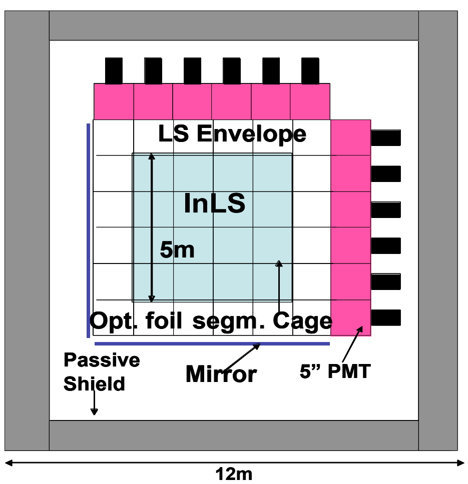



**Fig 1 Low energy neutrino spectrum from LENS**

**Scientific Impact:** The sun offers the highest matter density, the longest baseline, a well-defined _$_e$ flavor at the source and the highest _ flux compared to any terrestrial machine. All but 10$^{-4}$ of the flux is confined to low energies, dominantly in the pp neutrino continuum 0-420 keV. No spectral data is yet available below 5 MeV and all the current information comes from the tiny (10$^{-4}$) high energy (>5 MeV) part of the spectrum. A direct spectroscopic measurement of these neutrinos that contain specific fluxes at several energies will provide the ideal tool for probing flavor survival and non-standard _ phenomena at the earth and for precision measurements of the sun's neutrino luminosity




**Detector**: A conceptual design of LENS is shown in Fig. 2. The basic target assembly is 100-150 tons of In-loaded organic liquid scintillator (LS) containing 10-15 tons of natural indium. Along with a ~50cm thick buffer of non-In LS, the liquid is contained in a tank in which a cage of transparent double layer of plastic is installed. This cage optically segments the detector into small cubical volumes (7.5-12.5cm)$^3$ that set the fundamental granularity of the detector. We have shown that in this case the signal light propagates only along channels in the three coordinate axis of the event origin. The event location can thus be digitally recorded by coincident hits on 3 PMT's covering at least 3 sides of the cubic structure. The whole detector carries a passive shielding envelope of either water or iron.

**Requirements:** The depth requirement for LENS is relatively modest, >~2000 mwe so that space in the first phase laboratory in Homestake at ~4800 ft would be adequate. The space requirement is ~1800m$^3$ for the detector itself and probably an equal volume of laboratory space for preparation, storage etc. The required laboratory space must be enclosed, living-enabled and clean though not necessarily at the levels needed for very low background experiments.

**Collaboration:** The development of the LENS experiment is at present, being carried out by a Russian-US group of scientists. ***Russia***: Institute of Nuclear Research (Moscow and Troitsk), Institute of Theoretical and Experimental Physics Moscow. ***US***: Brookhaven National Lab, Oak Ridge National Lab, Princeton U, U. North Carolina Chapel Hill and Virgina Tech. The contact person is R. S. Raghavan, VT (phone 540-231-2761; email: raghavan@vt.edu).