Lawrence Berkeley National Laboratory
One Cyclotron Road
MS 88-R0192
Berkeley CA 94720-8101

December 21, 2005

South Dakota Science and Technology Authority
P.O. Box 8329
Rapid City, SD 57709

To the South Dakota Science and Technology Authority:

We would like to express our interest in performing experiments at the planned underground science research facility at the Homestake Mine. We are developing plans for a new high-current ion accelerator, which will be capable of measuring nuclear fusion reaction cross sections at unprecedented levels of accuracy. These reactions power the nuclear fusion cycles, which supply the energy of our sun and other main-sequence stars. Precise measurements of the reaction cross sections - beginning with our design goal reaction ^{3}He(^{4}He, gamma)^{7}Be - are necessary to interpret solar neutrino oscillation data, and will greatly improve our understanding of our own sun and other stars, and can inform cosmology theory through Big Bang Nucleosynthesis.

Measuring these reaction cross sections at energies typical of the stellar interiors (at or near the Gamow Peak energy) has been very difficult because the cross sections decrease exponentially with energy, while interpretation of measurements with high-energy beams is hampered by uncertainty in the extrapolations to low energies. There is strong motivation to perform these measurements at very low energies, despite the very low count rates in the experiments – usually measured in events per day. Our aim is to develop a high intensity, low-energy ion beam accelerator for measuring stellar fusion cross sections to enable precise cross section measurements below 100 keV. Despite our high design currents, we want to suppress cosmic ray backgrounds in these low-rate counting experiments, and the best approach to this problem is to site the accelerator facility deep underground.

While we are still in the design stage for our accelerator, we believe that it is in our interest to develop a machine, which can be assembled and operated in an underground laboratory, and we are including these considerations in our design process. We could anticipate installing the accelerator in the Homestake Mine underground science facility in about the year 2010, experiments could start about six months after the installation.

We anticipate that the technical requirements for operating such an accelerator in an underground facility would include:

- Installing a 300 kV high voltage platform, which should have easy access to change and service the ion source: The high voltage platform will be followed by a short beam line consisting of an accelerator column, several magnetic solenoids (current preliminary design includes 4 solenoids) and an analyzing magnet.
- LCW water cooling will be required for the ion source on the high voltage platform.

- A gas jet target will be used requiring a differential pumping system and gas recirculation system.
- The detector will consist of several segmented germanium detectors, which will require liquid nitrogen cooling
- Counting area for data acquisition

A more detailed conceptual design report and cost estimate will be available in June 2006. We are enthusiastic about the opportunity to perform these important experiments in the Homestake Mine in its incarnation as an underground science laboratory.

Sincerely,

Paul Vetter
Reina Maruyama
Rod Clark
Daniela Leitner
Matthaeus Leitner

Nuclear Science Division and Engineering Division
Lawrence Berkeley National Laboratory