

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

December 7, 2005

Dear Sirs,

We propose in this letter of interest the establishment of a multi-purpose laboratory called HEEL (Homestake Electrical Engineering Laboratory) for the study and development of materials, circuits, and solar cells within the interim 4850 laboratory at the Homestake Mine. Potential applications include, but are not limited to, the following ideas:

- (1.) The study of single event upsets and defects in electrical devices due to cosmic rays.
- (2.) The irradiation of circuits, solar cells, and other materials to be used in the space program.
- (3.) A facility for constructing and testing particle physics detectors and medical imaging devices to be used in the Homestake Mine and elsewhere.
- (4.) A location with restricted physical access for companies to store servers and perform research of their own.
- (5.) Clean rooms for the manufacture of electronics in a cosmic ray free environment.

In circuits, cosmic ray muons are responsible for single event upsets (SEU) that occur within circuits and other materials. As devices become smaller and smaller, the capacitances involved allow for a cosmic ray pulse to deliver charge to the circuit element. This not only can effect the memory stored (i.e. changing a "0" to a "1"), but the radiation can produce defects by displacement or conversion to other elements.

Studies performed in the reduced cosmic ray environment provided by the natural shielding of the Homestake Mine will effectively remove effects of the cosmic rays from the analysis. Long-term studies could be performed on the effect of cosmic rays on solar cells and circuits by placing control groups at low depths, and expose the other components at the surface.

Besides exposure to cosmic rays, other sources of radiation could be used to irradiate materials, solar cells, and circuits within the Mine, and then studied with similar materials science tools used for the study of cosmic rays. For example, the irradiation of solar cells is important for the design of radiation-hardened materials that can be used in the space program. South Dakota State would develop and manufacture solar cells, and they would be tested within the facility. In the future, perhaps accelerators will be built underground (if Homestake is

designated as DUSEL), and HEEL would utilize such an accelerator in the bombardment of different materials. It is conceivable that materials could also be launched from somewhere in the Black Hills via balloons into the upper atmosphere and exposed to cosmic radiation. HEEL would be the center of such operations.

HEEL would also serve as a testing facility for particle physics detectors used elsewhere in the Homestake Mine, or a place for the development and construction of said particle physics detectors. These are often calibrated using cosmic rays or other sources of radiation, so it may be a natural fit given the other analyses. Medical imaging equipment used in Positron Emission Tomography or other hardware applied in radiation therapy could be designed, constructed, and/or tested here.

We would welcome collaboration with other universities and companies. Under the umbrella of this electronics laboratory, servers could be housed in a secure physical location. In other words, it would be difficult to get in and out of the mine shaft without proper protocols. These servers would also benefit from the reduced cosmic ray environment since they would not be as susceptible to soft error upsets (SEUs).

As the infrastructure progresses, we anticipate that clean rooms would be built for the manufacture of electronics that would take advantage of the cosmic ray free environment, but other interested parties may take advantage of the proximity with the established testing facilities and the restricted access.

Thus we would request space not only underground, but also at the surface so that electrical devices could be studied with and without cosmic rays. A machine shop and office space would be required on the surface. Various materials science technologies, such as scanning electron microscopes, mass spectrometers, and fabrication labs would exist at the facility.

What benefits would such a facility hold? First, it would enhance the overall portfolio of research being done at the lab. It has the potential to attract many different hi-tech companies, and thus introduce an industrial component to the Homestake Mine that would complement the overall education/outreach and fundamental physics efforts.

Second, it would support and augment other functions at the Homestake Mine via its testing facilities and physical storage of servers. On-site construction of detectors could be performed within the auspices of HEEL. As the Homestake Mine develops, it would become a source of secondary users for new applications such as an accelerator.

Third, HEEL would be an important component in the future development of doctoral programs in the State of South Dakota for Electrical Engineering, Materials Science, and Physics.

Sincerely,

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