Justification

1. **Shielding:** Underground locations such as Homestake DUSEL can provide shielding from several sources of radiation that surface biology is exposed to, such as UV and some ionizing radiation. Establishing radiation levels in the mine at specific depths/locations is needed for several disciplines, including studies relating to mutation rates of microorganisms, both native and introduced, at different sites in the mine. While the contribution from cosmic rays should be significantly reduced by the rock in the mine, Radon and other radioimpurities in the surrounding rock and construction materials can be addressed and/or controlled via Radon-reduced air, low activity materials, and additional water and/or acrylic shielding with the low background counting group.

2. **Mutation rates of native and introduced microorganisms:** Studies of mutation rates of different microorganisms, both native and introduced, at different sites in DUSEL with known radiation fluxes will allow estimation of how much radiation contributes to mutation rates. Once the influence of radiation is accounted for, influences such as DNA replication errors will be better understood. Additional doses of radiation may be provided by sealed sources and/or interactions with the underground accelerator group.

3. **Isolation of other environmental factors:** Environmental influences such as desiccation and elevated temperature can increase the mutation rates of some organisms. The underground biosphere of Homestake has less variety and variability than the surface biosphere. It should be easier in the subsurface to assay the influence of environmental parameters like wetting/drying cycles and temperature extremes on *in situ* mutation rates, compared to surface habitats.

4. **Breakdown of lignocellulosics:** Extremophilic microorganisms (thermophiles; radiation resistant types; etc.) have been and will continue to be isolated from habitats in Homestake. Many of these isolates can break down lignocellulose or its components. Assaying these bioprocessing isolates for radiation resistance will be valuable. Radiation resistant isolates could be used in bioprocessing schemes where lignocellulosics are treated with radiation, then with microbes; or treated with radiation and microbes simultaneously; to see if a combination of radiation and microbial activity leads to enhanced disruption and conversion of the lignocellulosic matrix to metabolites including sugars or fermentation products.
Objectives

1. Determine radiation levels at selected depths/sites in DUSEL; and determine sources of the radiation (radon; etc.). See if correlation exists with depth of rock shielding from surface radiation and subsurface radiation levels. For microbes that have both a vegetative growth state and a dormant stage (spore), determine mutation rates for each form.

2. Conduct mutation experiments with selected microorganisms, including strains foreign to the mine and those native to the mine, at selected sites. See if mutation rates vary with depth/location. For microbes that have both a vegetative growth state and a dormant stage (spore), determine mutation rates for each form.

3. Conduct in situ mutation experiments on solid surfaces and in waters of mine; in habitats having different temperatures; to see how environmental parameters other than radiation affect mutation rates.

4. Assay radiation resistance of Homestake microbes in general & microbes from other habitats having potential for use in bioprocessing of lignocellulosics. Use different combinations of radiation treatments with microbiological treatments of lignocellulosics, separately and concurrently, to determine how treatment with microbes and radiation may be used to expedite breakdown of lignocellulosics.

Current Personnel:

Robert McTaggart: Project manager and radiation studies
Bruce Bleakley: Microbiology
Bill Gibbons: Microbiology and biomass applications for lignocellulosics
Gary Anderson: Biomass applications for algae, LED development
Qiquan Qiao: Development of Organic LED’s to provide UV