Improved radiation shielding

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The radiation shielding walls which separate the CEBAF tunnel and CHNESS measurement areas were designed and installed when CHNESS was first built. Since that time, particle beam currents and injection rates have steadily increased. Data collected during routine radiation monitoring and from surveys conducted in machine studies designed to anticipate radiation levels after the CEBAF upgrade suggest the need for improvements in the shielding of the tunnel walls.

In a cooperative effort, CHNESS and LNS (Laboratory for Nuclear Science) have studied sources of radiation that produce radiations in the cesium-137 area. The group has been responsible for the development and realization of new shielding designs. The result of this work, the new tunnel walls you will see on your next visit to CEBAF, will provide a level of radiations acceptable to the standards set by the New York State Department of Health for health and safety. The work was done by CHNESS and LNS staff. Our estimates on shielding improvements come from comparing the results of these studies against the results of experiments done in the past.

The new walls are designed to keep radiation in the CHNESS experimental areas near background levels for the foreseeable future. The design for the upgraded walls, the model for our heavy concrete and all the concrete casting was done by CHNESS and LNS staff. Our estimates of shielding improvements come from comparing the results of these studies against the results of experiments done in the past.

In the electromagnetic shower, several mechanisms dominate the production of particles. The primary mechanism is the bremsstrahlung photon. These photons are the most penetrating part of the shower, but they eventually degrade in energy and are lost in processes that create additional particles. The most interesting of these decay products are the mesons and muons. Neutrons are also produced.

The original CHNESS tunnel walls were built of 1 foot thick normal concrete with lead replacing concrete in a 1 foot tall section at beam height. We are presently replacing this with up to 2 feet of heavy concrete combined with a tunnel wide facing of lead. This new wall is designed to keep radiation in the CHNESS experimental areas near background levels for the foreseeable future. The design for the upgraded walls, the model for our heavy concrete and all the concrete casting was done by CHNESS and LNS staff. Our estimates of shielding improvements come from comparing the results of these studies against the results of experiments done in the past.

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Concrete mixtures are made up of aggregates that are typically about 20% lower than the heaviest mixes.

A second idea is to impregnate the pellets with a good neutron absorber such as boron. This would further improve the attenuation properties of the mixture. We have made such boron-rich samples and are awaiting burnoff at the Cornell Nuclear Reactor (Ward Lab) to test this notion.

We gratefully acknowledge the following individuals for their expert advice, cooperation and hard work on this project: Tim Bond, supervisor of Winter Lab helped in every aspect of concrete mixing and testing, and generously provided space for the concrete block fabrication. Clay Bell and his crew at LNS have expertly designed frames, manufactured steel blocks, and are responsible for installation of the tunnel walls. Bruno Cardile, of Quebec Carter Mining, offered his resources and advice on a number of technical points. Finally, Professor Douglas Winslow, a CHESS user from Purdue University, was an invaluable source of wisdom and technical help in evaluating the new material and in explaining the fundamentals of concrete engineering.

3. These are mixed, molded, and polished by Quebec Carter Mining Company, WO 1 McCall, College St. 1464, Moncton, Quebec Canada HIA 3H4.
4. American Concrete Institute, 59th Annual ACI Convention 1983.
5. ACI/AM/USNCRDC, 1979, and 1980/81 are found in Annual Book of ASTM Standards, Vol 04-02.