Proceedings of the 1999 Particle Accelerator Conference, New York, 1999

SUPERCONDUCTING RF LAB FACILITY UPGRADES AT LOS ALAMOS*

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1 ABSTRACT

Research and testing of multi-cell superconducting cavities demands extensive contamination control resources to achieve high-cavity fields. Facility upgrades at Los Alamos National Laboratory (LANL) included the modernization of test equipment, expanding and modernizing cleanroom facilities, improving safety, and expanding the high-pressure rinse cleaning process equipment. Each upgrade was integrated into the facility to enable users to assemble prototype cryomodules. The scope of the upgrades, the new installed capability, and budget and schedule for certain aspects of the project are discussed in this paper.

2 INTRODUCTION

Previous research at LANL focused on single-cell superconducting cavities at 805-MHz to 3-GHz. These cavities required minimal assembly and testing space. Testing larger 700-MHz multi-cell cavities, with the associated higher x-ray emissions, required the expansion of our current laboratory resources. We needed to increase floor space, reduce radiation exposure, and improve the procedure for handling the cavity test assembly.

3 PROJECT SCOPE

Facility upgrades for this project included the expansion of the 800 ft^2 class-100 cleanroom to approximately 2600 ft^2. This will accommodate processing and assembly of longer 5-cell 700-MHz cavities as well as scheduled cryomodule construction, utilizing up to four helium vessels. Outside the cleanroom, work on the cavity test area included adding x-ray shielding to the test area to better contain radiation. A mezzanine was added to support the cavity test structures for assembly.

3.1 Test Area

The Superconducting RF (SCRF) Lab, originally designed for the lower radiation levels resulting from single-cell cavity tests, needed additional shielding in the cryostat area for multi-cell cavity tests. Our goal was to contain the higher radiation levels expected from testing larger cavities, making personnel exposure consistent with ALARA (As Low As Reasonably Acheivable), a LANL policy. This prompted the design and development of a hydraulically operated shielding system. Since the cavity test structure is sunk below floor level, the majority of the x-rays are emitted vertically; the shielding was designed to accommodate this geometry. The type and quantity of material needed was determined through analysis. Typically, higher density materials provide more effective shielding. Due to its lower density and space constraint in the SCRF Lab, concrete was eliminated. Lead was also eliminated due to LANL's safety concerns with lead. The material chosen was steel. The goal was to keep the emissions below 100 mrem/hr measured at a 30 cm distance at full field level from the source. Analysis determined 8 inches of steel in the top, 2 inches on three sides, with 3 inches on the side closest to the test console, where personnel will be regularly stationed, would suffice. The shielding shown in Fig. 1, is moved over the test area by two hydraulic cylinders during energized testing.

Figure 1: Shielding system at LANL's SCRF Lab

To facilitate the handling of the cavity test assembly, a mezzanine was constructed as shown in Fig. 2. The mezzanine improves accessibility to the insert assembly, improving serviceability and eliminating top-heavy wheeled carts that were previously utilized.

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* Work supported by the US Department of Energy

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Figure 2: Mezzanine for cavity test assembly

3.1 Cleanroom

The old cleanroom, originally designed for single cell testing, needed more cleanroom floor space. In preparation for cleanroom installation, additional electrical circuits were needed, and we wanted to bring the building electrical up to code. The old electrical system routed circuits from panels to multiple rooms throughout the facility. During the upgrade, many of these circuits were rerouted such that each room would have its own panel. Panels and circuits were added, and existing circuits were rerouted. One panel was dedicated specifically to the cleanroom and its associated electrical. This approach reduced confusion and made for an easier cleanroom installation.

A great deal of work went into defining a cleanroom that would meet our needs. The floorplan, as shown in Fig. 3, was determined by cryomodule size, available floorspace, and our intended cleaning process. First we defined our space requirements by considering cavity and cryomodule size. We could neither infringe on the space of other tenants, nor could we add-on to the existing building. We planned to clean each piece of hardware in successively cleaner areas. Next we defined our cleaning process which included ultrapure water, compressed air to drive high pressure pumps, and ultrapure nitrogen for drying.

We began researching cleanroom contractors, to find one that could meet our needs. Clean Air Technology (CAT) was able to provide a modular cleanroom that would accommodate our unusual building geometry. CAT provided the cleanroom, a local general contractor provided the electrical, mechanical, fire protection and

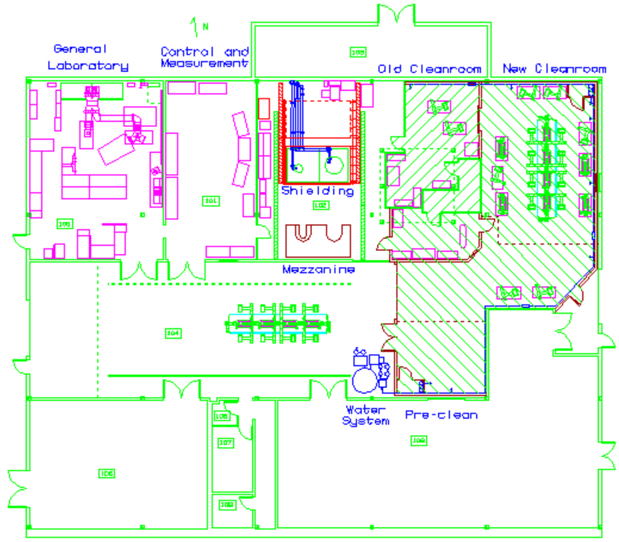

Figure 3: Current floorplan layout showing cleanroom, shielding, mezzanine and ultrapure water system

ultrapure water system work. While this approach supported the end goal, in retrospect, it would have been helpful to utilize a general contractor with experience in cleanroom installation. For example, on one occasion concrete was cut and removed generating dust during the assembly of the cleanroom, temporarily compromising cleanliness. A more experienced general contractor familiar with cleanroom installations understands the importance of cleanliness, and would plan tasks to maximize contamination control integrity. Constant oversight by an individual knowledgeable of the users needs and possessing the authority to make on-site decisions was critical to timely project completion. Issues related to project coordination and design arose frequently and most were dealt with on-site which helped maintain the momentum of the project.

3.2 Water System

A new larger capacity ultrapure water system was needed to clean the increased volume of the multi-cell cavities. Polyvinylidene fluoride (PVDF) piping was used in much of the system as well as to supply the cleanroom with ultrapure water for cleaning. The system is capable of delivering 2000 gallons per day of ultrapure water with the following water quality:

Residue	0.1	ppm
Total Oxidizable Carbon	5	ppb
Silica, dissolved	1	ppb
Particles/liter	500	counts

Water quality specification was based on ASTM grade E-2.

4 THEORY OF OPERATION

The facility improvements were designed to be used in concert with the goal of reliably achieving specified gradient at Q in cavities installed in a cryomodule. The installed cleanroom and ultrapure water system are used to rinse cavities after buffered chemical polishing (BCP) and to clean cavities by spraying them with ultrapure water at high pressure. The cavities would then be sealed and transported and affixed to cavity testing inserts that are suspended on the mezzanine. Cavity vertical testing would be done to determine if the cavities made the specified field at Q and to evaluate the limiting mechanism. The installed radiation shielding over the vertical test cryostats is required for reducing personnel exposure to the higher x-ray levels that are produced from the multi-cell superconducting cavities during field emission.

The tested cavity would then be taken back into the clean room where the cavity exterior is cleaned with high-pressure ultrapure water. The assembly procedure for the Accelerator Production of Tritium (APT) cryomodule necessitates all components assembled together in the cleanroom, e.g., cavities, power couplers, flanges, and cryomodule support structures, be thoroughly cleaned with high-pressure ultrapure water. This step is needed to minimize possible contamination during cryomodule assembly that could degrade cavity performance.

5 COST AND SCHEDULE

One person was assigned to project controls, scheduling and budgeting. Schedules and budgets were updated on a biweekly basis, tracking progress and spending. Budget figures are presented in Table 1 for our project.

Cleanroom

Cleanroom construction and installation	$0.7M
Demolition, building mods, engineering, design, inspection, project management	$1.0M
Total Project Cost	**$1.7M**

Shielding and Mezzanine

Shielding construction and installation	$100K
Mezzanine construction and installation	$ 15K
Demolition, electrical, mechanical	$ 65K
Total Project Cost	**$180K**

Table 1: Budget for SCRF Lab Facility Upgrade

The project was originally scheduled for January-October ’98, however delays extended the schedule into December ’98. This schedule reflects all facets of the project, initial concept development, assembling a project team, forming the design team, soliciting contractors, project construction, and inspection. Some schedule slip can be attributed to difficulties in scheduling outages for electrical and fire protection systems. Outages had to be coordinated with other tenants in the building and those being fed power from our facility.

6 CONCLUSION

LANL now has a cleanroom totaling 2600 ft^2. The pre-assembly areas are class-1000 environments while the main assembly area is a class-100 environment, a photo is shown in Fig. 4. The facility upgrades project gives

Figure 4: Inside cleanroom at Superconducting RF Lab

LANL a greatly increased capability for testing superconducting cavities. We now have the ability to clean and test 700 MHz multi-cell cavities, and can construct cryomodules inside a class-100 cleanroom.

The shielding system allows cavity testing at higher field levels while reducing worker exposure to radiation, complying with ALARA policy. Adding a mezzanine reduced manual labor and provided easier access to the cavity test assemblies. It provided a stable platform from which to work and eliminated ladder usage.

7 ACKNOWLEDGEMENT

The authors would like to thank the personnel of PM (Project Management) Division and BUS-5 (Business Operations, Procurement) group at LANL who graciously contributed and made this project a success.